A. E. COLLINS, M. Inst. C.E.
PAST PRESIDENT.

PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXXII. 1905-1906

EDITED BY

THOMAS COLE
ASSOC. M. INST. C.E.
(*Secretary of the Association*)

The Association is not as a body responsible for the facts and opinions advanced herein.

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Secretary.

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Telegraphic Address: "Bisecting, London."

Telephone Number: "5083 Westminster."

PAST PRESIDENTS.

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1876–7.	JAMES LEMON, M. INST. C.E.
1877–8.	*F. ASHMEAD, M. INST. C.E.
1878–9.	G. F. DEACON, LL.D., M. INST. C.E.
1879–80.	*E. PRITCHARD, M. INST. C.E.
1880–1.	*A. W. MORANT, M. INST. C.E.
1881–2.	*W. S. TILL, M. INST. C.E.
1882–3.	C. JONES, M. INST. C.E.
1883–4.	W. H. WHITE, M. INST. C.E.
1884–5.	*W. G. LAWS, M. INST. C.E.
1885–6.	*R. VAWSER, M. INST. C.E.
1886–7.	J. LOBLEY, M. INST. C.E.
1887–8.	*J. GORDON, M. INST. C.E.
1888–9.	E. B. ELLICE-CLARK, M. INST. C.E.
1889–90 1890–91	H. P. BOULNOIS, M. INST. C.E.
1891–2.	T. DE C. MEADE, M. INST. C.E.
1892–3.	J. CARTWRIGHT, M. INST. C.E.
1893–4.	J. T. EAYRS, M. INST. C.E.
1894–5.	A. M. FOWLER, M. INST. C.E.
1895–6.	*E. R. S. ESCOTT, M. INST. C.E.
1896–7.	*F. J. C. MAY, M. INST. C.E.
1897–8.	SIR ALEX. R. BINNIE, M. INST. C.E.
1898–9.	O. C. ROBSON, M. INST. C.E.
1899–1900.	W. HARPUR, M. INST. C.E.
1900–01.	*C. H. LOWE, M. INST. C.E.
1901–02.	E. GEORGE MAWBEY, M. INST. C.E.
1902–03.	T. H. YABBICOM, M. INST. C.E.
1903–04.	W. WEAVER, M. INST. C.E.
1904–05.	A. T. DAVIS, M. INST. C.E.
1905–06.	A. E. COLLINS, M. INST. C.E.

* Deceased.

LIST OF MEMBERS.

It is particularly requested that every Change of Address may be communicated without delay to the Secretary.

* *Those Members against whose names a star is placed have obtained the Certificate of the Association.*

R *signifies re-election under By-law 5a.* G *elected as Graduate.* A *elected as Associate.* TA *transferred to Associate class.* T *transferred to Member.*

P *signifies recipient of Association's £10 premium.*

P „ „ „ £5 *premium.*

p „ „ „ £3 *premium.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1897 Oct. 16	BECHMANN, G.	Ingénieur en chef des Ponts et Chaussées, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1904 Feb. 27	COWAN, P. C., M.Inst.C.E.	Chief Engineering Inspector, Local Government Board, Ireland.
1901 Mar. 23	HASSELT, J. VAN	Director of Public Works, Amsterdam.
1905 Sept. 23	HAWKSLEY, CHARLES, M. Inst. C.E.	30 Great George Street, S.W.
1892 Apr. 23	PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, Professor HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, Major H., C.B., R.E.	28 Victoria Street, S.W.
1904 Jan. 23	WILLCOCKS, G. W., M. Inst. C.E.	Chief Engineering Inspector, Local Government Board, Whitehall, S.W.

MEMBERS.

1893 Oct. 21	Abrahams, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	Aburrow, C., M. Inst. C.E...	31/32 Bettelheim Buildings, Johannesburg, S.A.
1903 May 16	Adams, A. E...	Borough Engineer, Chippenham, Wilts.
1896 Jan. 18	Aitken, T., M. Inst. C.E. ..	County Surveyor, Cupar, Fife.
1897 Jan. 16	Allen, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2 R1884 Jan. 26	*Allen, T. T...	Broad Street, Stratford-on-Avon.

Date of Election and Transfer.		
1897 June 19	Alves, G.	Surveyor to the Urban District Council, Glastonbury.
1890 June 26	Anderson, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
1900 Dec. 15	Anderson, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
1906 Apr. 28	Andrew, J...	Burgh Surveyor, Dunoon, N.B.
G1898 June 30 T1899 Oct. 21	*Andrews, S. P.	Borough Surveyor, Faversham.
G1894 Oct. 20 T1899 Oct. 21	*Angel, R. J., M. Inst. C.E. ..	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*Angell, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1873 Feb. 15	ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer. Member of Council.*)	"Calside," Carlisle Road, Eastbourne.
1899 June 29	Anstee, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	Armistead, R., Assoc. M. Inst. C.E.	8 Charles Street, Bradford.
1900 June 16	Asquith, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	Atkinson, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
1904 Aug. 4	Atkinson, T. R.	County Surveyor, Earlston, Berwickshire, N.B.
1897 Feb. 13 R1905 Sept. 23	Baff, C. J.	Council Chambers, Gosforth, Newcastle-on-Tyne.
1904 Jan. 23	Baines, C. O.	Surveyor to the Urban District Council, Paignton.
1900 Feb. 10	Bains, G. S. L.	Surveyor to the Urban District Council, Saltburn-by-the-Sea.
1884 May 29	Baker, F.	Borough Surveyor, Middlesbrough, Yorks.
1891 Aug. 1 R1903 Feb. 21	Baker, J., A.M. Inst. C.E. ..	75 High Street, Slough.
1896 June 25	Baldwin, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
G1891 Aug. 1 T1896 Feb. 22	*Ball, B., A.M. Inst. C.E. ..	Borough Surveyor, Nelson, Lancs.
G1887 Sept. 17 T1898 Feb. 19	*Ball, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
1879 Oct. 23	Banks, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1905 Apr. 29	Barber, E. H., A.M.Inst.C.E.	Town Surveyor, Goole.
1887 Mar. 12	BARBER, J. PATTEN, M.Inst. C.E. (*President.*)	Borough Engineer, Islington, N.
1903 June 25	Barclay, J.	Surveyor to the Urban District Council, Chiswick.
G1901 Aug. 24 T1906 Apr. 28	*Barker, H. W.	Surveyor to the Urban District Council, Walmer.
G1888 Sept. 15 T1892 July 11	*Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1897 Jan. 16	Barrett, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1899 Jan. 21	Barrs, J. D.	Surveyor to the Urban District Council, Bromyard.

Date of Election and Transfer.		
1898 Jan. 15	BARTON, J. I..	1 St. Thomas' Street, Ryde, Isle of Wight.
G1903 Jan. 17 / T1905 May 27	*BATE, E. M.	Surveyor to the Urban District Council, Frinton-on-Sea.
1896 Oct. 24 / R1904 May 28	BAYLIS, T. P., Assoc. M. Inst. C.E.	Surveyor, Droitwich.
G1901 June 8 / T1903 July 25	*BEACHAM, W. E.	Town Surveyor, Leek.
1903 May 16	BEAN, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1894 Jan. 13	BEAUMONT, A.	County Surveyor, Yorks, East Riding. County Hall, Beverley.
1897 Mar. 13	BEAUMONT, G. E.	Surveyor to the Rural District Coun., Wortley. "Holme Lea," Greenoside, near Sheffield.
1897 Mar. 13	BEAUMONT, T. C.	Surveyor to the Rural District Council, Driffield.
1892 Jan. 16	BELL, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
1897 Jan. 16	BELL, G. J., M.Inst.C.E. ..	County Surveyor, Cumberland. Carlisle.
A1902 Jan. 25 / T1906 Dec. 15	*BELL, L. M., M.Inst.C.E. ..	Municipal Engineer, Penang, S.S.
1906 Apr. 28	BELL, T. H.	Surveyor to the Urban District Council, Ramsbottom.
1895 Jan. 19	BELLINGHAM, A. W. H., M. Inst. C.E.	Engineer-in-Chief, British Municip., Tientsin, North China.
1896 Jan. 18	BENNETT, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1886 Dec. 18 / R1902 Nov. 8	BENNETT, W. B. G., Assoc. M. Inst. C.E.	Midland Bank Chambers, Southampton.
G1898 Dec. 17 / T1900 July 19	*BENNETTS, J. P.	Surveyor to the Urban District Council, Harrow.
1886 Oct. 16 / R1896 Jan. 18	BERRINGTON, R. E. W., M. Inst. C.E.	Graisley, Wolverhampton.
1892 Mar. 11 / R1899 May 6	BESWICK, W. H., Assoc. M. Inst. C.E.	214 Astley Street, Dukinfield, Cheshire.
1891 June 6	BETTANY, F.	Borough Engineer, Burslem.
1902 Mar. 22	BIBBEY, T.	Surveyor to the Urban District Council, Audley, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	9 Gt. George Street, Westminster, S.W.
1896 Nov. 28	BIRD, W. F.	Surveyor to the Urban District Council, Midsomer Norton.
1897 Jan. 16	BIRKS, E.	Highway Surveyor to Rural District Council, Uxbridge.
1901 Feb. 16	BLACKBURN, J.	Surveyor to the Urban District Council, Soothill Upper.
P1873 May 2	BLACKSHAW, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
1904 Aug. 5	BLACKWOOD, R.	Burgh Surveyor, Kilmarnock, N.B.
1886 June 12	BLAIR, W. N., M. Inst. C.E. (*Vice-President.*)	Borough Surveyor, St. Pancras.
1903 Oct. 17	BLAND, J. D.	Surveyor to the Urban District Council, Chesterton.
1900 Mar. 10	BLOOD, A. T.	Surveyor to the Urban District Council, Hitchin.
1902 Nov. 8	BORG, E. A.	Borough Surveyor, Margate.

Date of Election and Transfer.		
1895 Jan. 19 B1903 Feb. 21	BOTTERILL, C., A.M.Inst.C.E.	583 Fulham Road, Walham Green, S.W.
1904 Feb. 27	BOTTOMLEY, H.	Surveyor to the Urban District Council, Bingley.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	Local Government Board, Whitehall, S.W.
1903 Dec. 12	BOURNE, J.	Surveyor to the Urban District Council, Rawmarsh.
1898 Mar. 19 B1903 Feb. 21	BOWEN, H. W.	District Surveyor, East Sussex County Council, Kingsley, Hassocks, Sussex.
1904 Aug. 12	BOWIE, J. McL.	Burgh Surveyor, Maxwelltown, Dumfries, N.B.
1898 Feb. 19	BOWLES, A. R., Assoc. M. Inst. C.E.	104 Sandgate Road, Folkestone.
1898 Oct. 15	BOYLE, J. C., A. M. Inst. C.E.	City Surveyor, Armagh.
1903 May 16	BRADLEY, A.W., A.M.Inst.C.E.	Borough Engineer, Bury, Lancs.
G1889 May 18 T1893 Apr. 22	*BRADLEY, J. W., M. Inst. C.E.	City Engineer, Westminster, S.W.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council, Tonbridge.
G1894 Jan. 13 T1896 Oct. 24	*BRADSHAW, F. E. G.	Borough Surveyor, Tamworth.
1873 May 2	BRESSEY, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	BRODIE, J. A., M. Inst. C.E. (*Vice-President.*)	City Engineer, Liverpool.
1889 Apr. 13	BRODIE, J. S., A.M. Inst. C.E.	Borough Engineer, Blackpool.
1905 Dec. 9	BROOKE, E.	City Engineer, Lichfield.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1885 Feb. 7 B1892 Apr. 23	BROOKE, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Strood. "Lympstone," Goddington Road, Rochester.
1884 July 10	BROWN, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A. M. Inst. C.E...	Borough Engineer, Chelmsford.
1904 Aug. 25	BROWN, CHAS.	Burgh Surveyor, Hawick, N.B.
1905 Jan. 28	BROWN, F.	Town Engineer, Kroonstad, O.R.C., South Africa.
1905 Sep. 23	BROWN, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
1881 June 18 B1904 Jan. 23	BROWN, J. W., M. Inst. C.E.	Church Square, West Hartlepool.
G1894 July 7 T1898 Sept. 3	*BROWN, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 B1898 Jan. 15	*BROWN, R. R.	Electrical Engineer to the Urban District Council, Bridlington.

Date of Election and Transfer.		
1893 Mar. 4	*BROWNRIDGE, C., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *Hon. Secretary*, Lancashire and Cheshire District.
1904 Aug. 9	BRUCE, J. S.	Burgh Surveyor, Kirriemuir, N.B.
1901 Feb. 16	BRYCE, J., A.M. Inst. C.E. (*Member of Council*).	Burgh Surveyor, Partick, N.B., *Hon. Sec.* Scottish District.
G1889 Feb. 9 T1902 Mar. 22	*BRYNING, W. G.	County Surveyor, Northallerton, Yorks.
1873 May 2	BUCKHAM, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8 R1902 Mar. 22	BUCKLEY, M. J., Assoc. M. Inst. C.E.	26 Bessborough Terrace, N.C.R., Dublin.
1897 Feb. 13	BULL, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
1895 Feb. 16	BUNTING, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	BURDEN, A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	BURGESS, S. E., M. Inst. C.E.	Borough Engineer, South Shields.
1900 Apr. 21	BURKITT, J. P., A.M. Inst. C.E.	County Surveyor, Enniskillen.
1905 Mar. 3	BURN, W., A. M. Inst. C.E...	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1904 Aug. 6	BURNS, D.	Burgh Surveyor, Pollokshaws, N.B.
1890 June 7	BURSLAM, R.	Borough Surveyor, Congleton.
G1895 Jan. 19 T1902 Jan. 25	*BURTON, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
1897 Jan. 16	BUSBRIDGE, T. A.	Surveyor to the Rural District Council, Spilsby.
G1899 June 29 TA1902 Jan. 25 T1904 Feb. 27	*BUSH, W. E., A. M. Inst. C.E.	City Engineer, Auckland, New Zealand.
1890 Sept. 13	BUTLER, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	BUTTERWORTH, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
1894 Apr. 6	CAINK, T., Assoc. M. Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12 R1903 Jan. 17	CAIRNCROSS, T. W., Assoc. M. Inst. C.E.	13 Duncan's Chambers, Shortmarket Street, Cape Town, S. Africa.
1903 Jan. 17	CALDER, W., A. M. Inst. C.E.	City Engineer, Prahran, Victoria.
1891 Oct. 17	CAMPBELL, A. H., M. Inst. C.E.	Engineer and Surveyor, Town Hall, East Ham, E.
1887 Mar. 12	CAMPBELL, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
1888 May 12	CAPON, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 R1899 Jan. 21	CARD, H...	North Street, Lewes.
1903 Feb. 21	CARTER, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.
1901 June 27	CARTER, G. E.	Surveyor to the Rural District Council, Winchester.

Date of Election and Transfer.		
1897 June 19	CARTER, G. F.	Surveyor to the Urban District Council, Mexborough.
G1892 July 11 TA1901 Dec. 7 T1904 Jan. 23	*CARTER, G. F., A.M.Inst.C.E.	Borough Engineer, Croydon.
1898 Dec. 17	CARTWRIGHT, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	21 Parsons Lane, Bury.
1904 June 26	CARVER, W.	Surveyor to the Rural District Council, Melford. 3 Melford Road, Sudbury, Suffolk.
1895 Mar. 16	CASS, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
1895 Mar. 16 R1899 Feb. 25	CATT, A. J.	"Laurel Dene," Kingston-by-Sea, near Brighton.
1896 Mar. 21	CHADWICK, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	CHAMBERS, S. H.	Surveyor to the Urban District Council, Hampton.
1901 Dec. 7	CHANCELLOR, W. B.	Surveyor to the Urban District Council, Brownhills, Staffs.
1897 Jan. 16	CHAPMAN, C. R. W.	Surveyor to the Urban District Council, Wembley.
1893 Mar. 4 R1899 May 6	CHARLES, T.	Bessborough Road, Harrow.
1884 Dec. 20	CHART, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1900 Feb. 10	CHOWINS, W. H.	Surveyor to the Urban District Council, Burnham, Somerset.
1906 Mar. 3	CHRISTIE, S. L.	Burgh Surveyor, Montrose, N.B.
1884 Oct. 9	CLARE, J., A.M. Inst. C.E...	Surveyor to the Urban District Council, Sleaford.
1898 Sept. 3	CLARK, E. O'N.	County Surveyor, Leitrim.
A1902 May 10 T1904 Apr. 30	CLARKE, G. E.	Borough Surveyor, Boston, Lincolnshire.
1899 Oct. 21	CLARKE, H. A.	Surveyor to the Urban District Council, Briton Ferry.
1898 Oct. 15	CLARRY, W. H., A. M. Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18	CLARSON, H. J.	Surveyor to the Rural District Council, Tamworth.
1901 May 11	CLAYTON, F. T.	Borough Engineer, Reigate.
1893 July 31	CLOUGH, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21	CLUCAS, R. H.	Borough Surveyor, Kingston-on-Thames.
G1894 July 7 T1896 Oct. 24	*COALES, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12	*COALES, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30	COCKRILL, J. W., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern District.
1893 June 24	COCKRILL, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1904 June 26	COLEBY, H. J.	Surveyor to the Rural District Council, Atherstone, Warwickshire.

Date of Election and Transfer.		
1892 Sept. 24	COLLEN, W. M.A., M.Inst.C.E.	County Surveyor, Dublin. 9 Hume Street, Dublin.
1897 July 31	COLLINGWOOD, T. A.	Surveyor to the Urban District Council, Itchen, Woolston, Southampton.
1888 May 12	COLLINS, A. E., M.Inst.C.E. (*Past President. Member of Council.*)	City Engineer, Norwich.
1900 Oct. 15 R1901 June 27	COLLINS, G. M.	103 Clarendon Road, Whalley Range, Manchester.
1896 Jan. 18	COLLINS, R.	Surveyor to the Urban District Council, Enfield, N.
1905 Apr. 29	COLLINS, W. A.	Surveyor to the Rural District Council, Bridgwater.
1886 May 1 R1897 Feb. 13	COMBER, P. F., M. Inst. C.E.	19 Lower Leeson Street, Dublin.
G1897 July 31 T1900 Dec. 15	*COOK, F. C.	Surveyor to the Urban District Council, Nuneaton.
1893 Apr. 22	COOK, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29	*COOK, J., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Cape Town, S. Africa. *Hon. Sec.* African District.
G1888 July 12 T1890 Mar. 29	*COOPER, C. H., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Wimbledon. 15 Dora Road, Wimbledon Park, S.W.
1898 Sept. 3	COOPER, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20	COOPER, F. A., C.M.G., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17	COOPER, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22 R1902 Nov. 8	COPLEY, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Nov. 28	CORBETT, J.	Borough Engineer, Salford.
1896 Jan. 18	CORDON, R. C.	Surveyor to the Rural District Council, Belper. "Belmont," Duffield, near Derby.
G1896 May 29 T1897 June 19	*CORRIE, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 June 21 R1903 Jan. 17	COTTERELL, A. P. I., M.Inst. C.E.	28 Baldwin Street, Bristol; and 17 Victoria Street, S.W.
1906 Mar. 3	COTTLE, F.	Borough Engineer, Douglas, Isle of Man.
1891 June 25 R1897 July 31	COVERLEY, J. S.	Surveyor, Penmaenmawr.
1898 May 21	COX, J.	Surveyor to the Urban District Council, Margam, Port Talbot.
P1880 Feb. 7	COX, J. H., M. Inst. C.E. ..	City Surveyor, Bradford.
1900 Mar. 10	CRABTREE, W. R., M.Sc.(Vict.), A. M. Inst. C.E.	Highway Surveyor to the Rural District Council, Doncaster.
P1881 May 6	CREER, A., Assoc. M. Inst.C.E. (*Member of Council.*)	City Surveyor, York.
1900 July 19	CROSS, A. W., A. M. Inst. C.E.	Surveyor to the Urban District Council, King's Norton.

Date of Election and Transfer.		
1889 Dec. 14	*CROWTHER, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
G1900 Jan. 19 T1903 May 16	*CRUMP, E. H.	Surveyor to the Urban District Council, Hinckley.
G1898 June 30 T1904 Apr. 30	*CUDBIRD, T. O.	Borough Surveyor, Beccles.
1900 June 16	CUMMING, W.	Highway Surveyor to the Rural District Council, Lanchester, co. Durham.
1889 Dec. 14	CURRALL, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	CURRY, W. F.	P.W.D., Pretoria, South Africa.
1893 Mar. 4 R1899 Feb. 25	CURRY, W. T., A. M. Inst.C.E.	Ruabon, North Wales.
1897 Feb. 13	CUTLER, H. A., A.M.Inst.C.E. (*Member of Council.*)	City Surveyor, Belfast.
1893 June 24	*DALTON, J. P. .. .. .. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne; *Hon. Secretary*, Northern District.
1899 Jan. 21	DAVIDSON, J. F.	Surveyor to the Urban District Council, Willington Quay.
1900 Oct. 15	DAVIES, W. J.	Surveyor to the Urban Dristrict Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., M. Inst. C.E. (*Past President. Member of Council.*)	County Surveyor, Salop. Shrewsbury.
1900 Oct. 15	*DAWSON, C. F.	Surveyor to the Urban District Council, Barking.
1884 Apr. 19 R1902 Nov. 8	DAWSON, C. J.	Wykeham House, Barking.
1896 July 25	DAWSON, N. H.	Borough Surveyor, Banbury.
1879 May 1	DAWSON, W., M. Inst. C.E.	Surveyor to the Urban District Council, Leyton, N.E.
1898 Jan. 15	DAY, C.	Borough Surveyor, Chatham.
1873 Dec. 9	DEACON, G. F., LL.D. (Glasgow), M. Inst. C.E. (*Past President.*)	16 Great George Street, Westminster, S.W.
1898 Jan. 15	DEANE, J. W...	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*DEARDEN, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1904 July 14	DELANY, J. F.	City Engineer, Cork.
P1890 Feb. 1	DENNIS, N. F., A.M.Inst.C.E.	Borough Engineer, West Hartlepool.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 June 10	*DICKINSON, A. J.	Surveyor to the Urban District Council, Redditch.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1890 Sept. 13 R1896 Jan. 18	DICKINSON, T. R., Assoc. M. Inst. C.E.	Burton House, Clifton, York.
1900 Feb. 10	DIGGLE, JAMES	Surveyor to the Urban District Council, Matlock.

Date of Election and Transfer.		
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1889 Sept. 21	DIGGLE, WM.	Surveyor to the Rural District Council, Runcorn. Frodsham, Chester.
1877 Oct. 20	DITCHAM, H.	Borough Surveyor, Harwich.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Desborough.
1897 Jan. 16 / B1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	Waterworks Engineer, Harrogate.
G1891 Aug. 1 / T1896 Oct. 24	*DIXON, J. R., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Town Hall, Woolwich. *Hon. Secretary*, Metropolitan District.
1887 June 18	DIXON, R., Assoc.M.Inst.C.E.	Borough Surveyor, Stratford-on-Avon.
1889 July 4	DODD, P., Assoc. M. Inst.C.E.	Borough Surveyor, Western District, Wandsworth, S.W.
1897 Jan. 16	*DODGEON, A.	Surveyor to the Urban District Council, Clayton-le-Moors.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
G1903 June 25 / T1904 Sept. 17	*DOUGLAS, S.	Surveyor to the Urban District Council, Kenilworth.
1906 Jan. 20	DOUGLASS, W. L., Assoc. M. Inst. C.E.	District Engineer, Middle Ward, Lanark County. District Offices, Hamilton, N.B.
1899 Oct. 21	DRYLAND, A., A. M. Inst. C.E.	County Surveyor, Hereford.
1891 Dec. 12	DUFFIN, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 / B1901 June 8	DUNCH, T. H.	27 Clement's Lane, Lombard Street, E.C.
1898 May 21	DUNN, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
1873 Feb. 15	DUNSCOMBE, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster, S.W.
G1891 Jan. 21 / T1892 Sept. 24	*DYACK, W., M. Inst. C.E. ..	Burgh Surveyor, Aberdeen.
1882 June 29	DYER, S...	Engineer to the Rural District Council, Bridlington.

1879 May 1	EARNSHAW, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1904 Aug. 3	EASTON, W. C., B. Sc., M. Inst. C.E.	Glasgow Main Drainage Works, Partick, N.B.
1900 May 19 / B1901 Dec. 7	*EASTWOOD, J., A.M. Inst. C.E.	2 Dunkirk Crescent, Halifax.
1883 Aug. 4	EATON-SHORE, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1877 Nov. 18	EAYRS, J. T., M. Inst. C.E. (*Past President.*)	39 Corporation Street, Birmingham.
1890 May 3	EBBETTS, D. J.	Surveyor to the Urban District Council, Acton.
1890 Feb. 1	EDDOWES, W. C.	Borough Surveyor, Shrewsbury.

Date of Election and Transfer.		
1891 Jan. 21 R1896 Jan. 18	*EDGE, F. J., M. Inst. C.E. ..	22 Collingwood Buildings, Newcastle-on-Tyne.
1891 Sept. 12	EDMONDSON, S.	Surveyor to the Rural District Council, Burnley.
1904 Jan. 23	EDWARDS, H. C. J., Assoc. M. Inst. C.E.	Borough Engineer, Lambeth.
1897 July 31	*ELFORD, E. J.	Borough Surveyor, Southend-on-Sea.
1885 Oct. 3	ELFORD, J.	Consulting Engineer, Poole.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
1900 Apr. 21	ELLIOTT, F. T.	"Woodbine," Albion Road, Birchington-on-Sea.
1895 July 27	ENTWISLE, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
1897 Jan. 16	EVANS, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	EVANS, E. L., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	EVANS, J. P.	Surveyor to the Rural District Council, Wrexham.
1903 Oct. 17	EVANS, S.	County Surveyor, Mold, Flintshire.
1890 June 7	FAIRLEY, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and 69 Victoria Street, S.W.
G1898 June 30 T1899 Feb. 25	*FARNHAM, W. A.	Surveyor to the Urban District Council, Foots Cray. Sidcup.
1887 July 14	FARRALL, T.	Surveyor to Urban District Council, Sherborne, Dorset.
1893 July 31	FARRINGTON, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.
1896 Jan. 18	FARRINGTON, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1896 Nov. 28	FEATHER, F.	Surveyor to the Urban District Council, Cheriton, near Folkestone.
1900 Dec. 15	*FELLOWS, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 13	FENN, T...	Surveyor to the Urban District Council, Belper.
1887 Sept. 17 R1899 June 10	FIDDIAN, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
P1899 Jan. 21	FIDLER, A., M. Inst. C.E. .. (*Member of Council.*)	Borough Engineer, Northampton.
G1891 June 25 T1906 Sept. 22	*FINCH, A. R., A. M. Inst. C.E.	Borough Surveyor, Kensington.
G1898 June 30 T1904 Jan. 23	*FINCH, E. E., A. M. Inst. C.E.	Borough Engineer, Bethnal Green.
1904 Nov, 18	FINDLAY, J. R.	Burgh Surveyor, Leith, N.B.
1894 Jan. 13	FINDLAY, R., A.M. Inst. C.E.	Surveyor, Eltham Green, S.E.
1903 May 16	*FINGLAH, F. J.	Borough Engineer, Carmarthen.

Date of Election and Transfer.		
G1892 May 28 T1897 Jan. 16 R1903 July 25	*Fitton, G.	Thornfield, Urmston Lane, Stretford, Manchester.
1903 May 16	Fitzmaurice, M., C.M.G., M. Inst. C.E.	Chief Engineer, London County Council, Spring Gardens.
1895 Oct. 19	Fleming, M. J.	Borough Surveyor, Town Hall, Waterford.
1893 Jan. 14 R1899 May 6	Flower, T. J. M., Assoc. M. Inst. C.E.	Scottish Buildings, Baldwin Street, Bristol; and 28 Victoria Street, Westminster, S.W.
1906 Sept. 22	Forbes, A.	County Road Surveyor, Linlithgow, N.B.
G1895 July 27 T1899 Jan. 21	*Forbes, A. H.	Surveyor to the Urban District Council, Saffron Walden.
1896 Nov. 28	Ford, G...	City Surveyor, St. Albans.
1890 Sept. 13 R1905 Jan. 28	Foster, T.	51 State Insurance Buildings, Dale Street, Liverpool.
1873 May 2	FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester.
G1896 Jan. 18 TA1904 May 28 T1906 May 26	*Fox, Sen., F. L., Assoc. M. Inst. C.E.	Borough Surveyor, Luton.
1897 Mar. 13	Fox-Allin, C. J.	Surveyor to the Urban District Council, Smethwick.
G1898 June 30 T1902 Nov. 8	*Fraser, R. W.	Surveyor to the Urban District Council, Hoylake, Cheshire.
1895 Oct. 19	Frost, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 R1898 Jan. 15	Fry, W. H., A.M. Inst. C.E.	9 High Street, Gosport.
1877 Oct. 20	Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road, S.E.
1885 June 6	Gammage, J.	Borough Surveyor, Dudley.
1891 Dec. 12 R1899 June 10	Garratt, C. T.	Estate Office, Newtown Linford, Leicestershire.
1894 Mar. 3	Garrett, J. H.	County Surveyor, Worcester.
1886 Mar. 13 R1902 Feb. 22	Gaskell, P.	Albert Chambers, Carr Lane, Hull.
1902 Jan. 25	Gent, T. W. B.	Surveyor to the Rural District Council, Leigh.
1902 Feb. 22	George-Powell, J.	Surveyor to the Rural District Council, Godstone, Surrey.
1905 Jan. 28	Gettings, C. F.	Surveyor to the Urban District Council, Teignmouth.
1901 Oct. 19	Gibbs, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	Gibson, S.	Surveyor to the Urban District Council, Biddulph.
1889 Dec. 14	Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge. 70 Quarry Hill, Tonbridge.

Date of Election and Transfer.		
1899 June 10	GLADWELL, A.	Highway Surveyor, Rural District Council, Eton. 1 Wrexham Road, Slough, Bucks.
1904 Jan. 23	GLEDHILL, G.	Surveyor to the Urban District Council, Balby with Hexthorpe.
1893 May 13	*GLOYNE, R.M., M. Inst. C.E.	District Engineer, Spring Gardens, S.W.
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
1904 Feb. 27	GOLDSWORTHY-CRUMP, T. ..	Surveyor to the Rural District Council, Taunton. 8 St. George's Terrace, Wilton, Taunton.
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
1899 June 10	GOUDIE, A. H.	Burgh Engineer, Stirling, N.B.
G1897 June 19 T1901 Dec. 7	*GRANT, F. T...	Borough Surveyor, Gravesend.
1905 Sept. 23	GRAY, C. C.	Surveyor to the Urban District Council, Hayes.
G1887 Feb. 5 PPT1898 Apr. 22	*GREATOREX, A.D., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, West Bromwich.
1895 Mar. 5	GREEN, A. A.	Borough Surveyor, Brackley.
1899 June 10	GREEN, G., A.M. Inst. C.E...	Borough Engineer, Wolverhampton.
1901 Feb. 16	GREEN, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	GREEN, W.	Surveyor to the Urban District Council, Castleford.
A1901 Dec. 7 T1903 Dec. 12	GREENSHIELDS, N., Assoc. M. Inst. C.E.	Borough Engineer, Bedford.
1890 May 3 B1898 Apr. 23	GREENWELL, A., Assoc. M. Inst. C.E.	30 Furnival Street, Holborn, E.C.
1883 May 5 B1891 Dec. 12	GREENWOOD, A.	39 Calder Street, Todmorden.
1898 Mar. 19	GREGORY, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	GREGSON, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	GREGSON, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1882 Sept. 30	GRIEVES, R.	Surveyor to the Urban District Council, Cowpen, Blyth, Northumberland.
1897 June 19	GRIEVES, W. H.	Surveyor to the Urban District Council, Buxton.
1904 Oct. 29	*GRIFFITHS, H. Ll., ...	Borough Surveyor, Brecon.
1886 Sept. 11	GRIMLEY, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
1899 Dec. 16	GRIMSHAW, F. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Atherton.
1898 Dec. 17	GUILBERT, T. J.	States Surveyor, Guernsey.
1892 Apr. 28	GUNNIS, J. W.	County Surveyor, Longford, Ireland.
1890 Mar. 29	GUNYON, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Wood Green, N.

Date of Election and Transfer.		
1891 Dec. 12	HACKETT, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
1897 June 19	HAGUE, S.	Borough Surveyor, Dukinfield.
1885 June 6	HAIGH, J., A.M. Inst. C.E. ..	Borough Surveyor, Abergavenny.
1906 June 28	*HAILSTONE, T. H.	Borough Surveyor, Richmond, Yorks.
1896 Apr. 25	HAINSWORTH, M.	Surveyor to the Urban District Council, Teddington.
1902 Sept. 6	HALE, A.	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*HALL, C...	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	HALL, E.	Borough Surveyor, Carnarvon.
1884 Apr 19 R1903 Mar. 21	HALL, J., M. Inst. C.E. (*Member of Council.*)	Executive Engineer, Municipal Offices, Bombay (*Hon. Secretary*, Indian District).
1886 May 1	HALL, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Great Crosby.
1900 June 16	HALLAM, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	HALLER, J. C.	Surveyor to the Urban District Council, Carlton, near Nottingham.
1905 June 22	*HALSTEAD, B.	Surveyor to the Urban District Council, Brierfield, Lancs.
1894 July 7	HAMAR, A.	Borough Surveyor, Bishop's Castle, Shropshire.
1887 Mar. 12	HAMBY, G. H., Assoc. M. Inst. C.E.	Borough Engineer, Lowestoft.
1904 Mar. 26	HAMMOND, H.	County Engineer, Hobson C.C., Auckland, New Zealand.
1897 Feb. 13	HAMP, H. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, New Swindon.
1897 Mar. 13	HANSON, J. H.	Surveyor to the Urban District Council, Cottingham, Yorks.
1890 Sept. 13	HANSON, W.	Surveyor to the Urban District Council, Wantage.
1896 Jan. 18	HARA, R.	Engineer to Tokio Fu, Japan.
1873 Feb. 15	HARDING, J. R.	Ashley Road, Epsom, Surrey.
G1896 Nov. 28 T1899 June 10	*HARDING, W. D.	Borough Engineer, Bury St. Edmunds.
1899 June 29	*HARGREAVES, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
1899 May 6	HARMAN, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	HARPUR, A. O.	Surveyor to the Urban District Council, Caerphilly.
1905 Jan. 28	HARPUR, J. L.	Town Surveyor, Brierley Hill.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Cardiff.
1896 Jan. 18	HARRIS, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
1901 May 11	HARRISON, A., M.Inst.C.E. ..	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.

Date of Election and Transfer.		
1895 Jan. 19 B1903 Feb. 21	BOTTERILL, C., A.M.Inst.C.E.	583 Fulham Road, Walham Green, S.W.
1904 Feb. 27	BOTTOMLEY, H.	Surveyor to the Urban District Council, Bingley.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	Local Government Board, Whitehall, S.W.
1903 Dec. 12	BOURNE, J.	Surveyor to the Urban District Council, Rawmarsh.
1898 Mar. 19 B1903 Feb. 21	BOWEN, H. W.	District Surveyor, East Sussex County Council, Kingsley, Hassocks, Sussex.
1904 Aug. 12	BOWIE, J. McL.	Burgh Surveyor, Maxwelltown, Dumfries, N.B.
1898 Feb. 19	BOWLES, A. R., Assoc. M. Inst. C.E.	104 Sandgate Road, Folkestone.
1898 Oct. 15	BOYLE, J. C., A. M. Inst. C.E.	City Surveyor, Armagh.
1903 May 16	BRADLEY, A.W., A.M.Inst.C.E.	Borough Engineer, Bury, Lancs.
G1889 May 18 T1893 Apr. 22	*BRADLEY, J. W., M. Inst. C.E.	City Engineer, Westminster, S.W.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council, Tonbridge.
G1894 Jan. 13 T1896 Oct. 24	*BRADSHAW, F. E. G.	Borough Surveyor, Tamworth.
1873 May 2	BRESSEY, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
1901 Dec. 7	BRODIE, J. A., M. Inst. C.E. (*Vice-President.*)	City Engineer, Liverpool.
1889 Apr. 13	BRODIE, J. S., A.M. Inst. C.E.	Borough Engineer, Blackpool.
1905 Dec. 9	BROOKE, E.	City Engineer, Lichfield.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
1885 Feb. 7 B1892 Apr. 23	BROOKE, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Strood. "Lympstone," Goddington Road, Rochester.
1884 July 10	BROWN, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A. M. Inst. C.E...	Borough Engineer, Chelmsford.
1904 Aug. 25	BROWN, CHAS.	Burgh Surveyor, Hawick, N.B.
1905 Jan. 28	BROWN, F.	Town Engineer, Kroonstad, O.R.C., South Africa.
1905 Sep. 23	BROWN, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
1881 June 18 B1904 Jan. 23	BROWN, J. W., M. Inst. C.E.	Church Square, West Hartlepool.
G1894 July 7 T1898 Sept. 3	*BROWN, R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Southall Norwood.
1889 Feb. 9 B1898 Jan. 15	*BROWN, R. R.	Electrical Engineer to the Urban District Council, Bridlington.

Date of Election and Transfer.		
1902 July 10	*HINES, C. E.	Surveyor to the Urban District Council, Windermere.
1898 Sept. 3	HIRST, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1895 June 27	HODGSON, W...	Surveyor to the Urban District Council, Keswick.
P1873 Feb. 15 R1885 Dec. 19	HODSON, G., M. Inst. C.E. ..	Loughborough.
1896 Apr. 25 R1901 May 11	*HOGBIN, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
1890 Feb. 1	HOLDEN, J., A.M. Inst. C.E.	Surveyor to the Rural District Council, Llandaff. Ely, Cardiff.
1897 Jan. 16	HOLE, W. P.	Borough Surveyor, Montgomery. Crowther's Hall, Welshpool.
1904 Aug. 16	HOLMES. F. G.	Burgh Surveyor, Govan, N.B.
1892 Mar. 11	HOLMES, G. W., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Walthamstow, N.E.
G1903 Dec. 12 T1904 Oct. 29	*HOLT, R. B.	Permanent Way Engineer, Wellington Bridge, Leeds.
1901 Dec. 7	*HOLT, W.	Surveyor to the Urban District Council, Sale, Cheshire.
1884 Oct. 9	HOOLEY, COSMO C., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-upon-Irwell. Croft's Bank House, Davyhulme, nr Manchester.
1884 Oct. 9	HOOLEY, E. P., M.Inst.C.E. (*Member of Council.*)	County Surveyor, Nottingham.
1898 Jan. 15	HOPKINSON, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 40 Bridge Street, Worksop.
1891 Dec. 12	HORAN, J., M.E., M.Inst.C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
1895 July 27	HORSFALL, W. H. D.	Surveyor to the Urban District Council, Southowram. 9 Harrison Road, Halifax.
1900 May 19	HORSFIELD, J. NIXON	Surveyor to the Urban District Council, Hampton Wick Kingston-on-Thames.
A1902 Feb. 22 T1906 Nov. 3	HORTON, J. W., Assoc.M.Inst. C.E.	County Surveyor, Derbyshire.
1894 Mar. 3	HOWARD, H.	Surveyor to the Urban District Council, Littlehampton.
P1889 Dec. 14 R1898 Oct. 15	HOWARD-SMITH, W., Assoc. M. Inst. C.E.	"Arosa," Amersham Hill, High Wycombe.
1880 May 27	HOWCROFT, J...	Surveyor to the Urban District Council, Redcar, Yorkshire.
1894 June 21	HOWELL, F. G.	County Surveyor, Surrey. Kingston-on-Thames.
1896 Feb. 22	HOWSE, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	HUGHES, H. T.	Highway Surveyor, Hayfield Road. Chapel-en-le-Frith.
1897 Jan. 16	HUMPHREYS, J.	Surveyor to the Urban District Council, Maesteg.
1899 June 1	HUMPHRIES, H. H.	Surveyor to the Urban District Council, Erdington.
1894 June 21	HUNT, G. J.	Borough Engineer, Dorchester.

Date of Election and Transfer.		
1897 July 8	HUNTER, T.	Surveyor to the Urban District Council, Leigh.
G1891 Aug. 1 T1896 Apr. 25	*HURD, H.	Surveyor to the Urban District Council, Broadstairs.
G1901 Aug. 24 T1901 Dec. 7	*HUTTON, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 T1903 Mar. 21	HUTTON, S.	Surveyor to the Urban District Council, Exmouth.
1898 May 21 B1906 Mar. 3	INGAMELLS, E. W...	Surveyor, Pokesdown.
G1895 Apr. 20 T1896 Oct. 24	*INGHAM, W., A.M. Inst.C.E.	Hydraulic Engineer, Port Elizabeth, South Africa.
1899 Feb. 25	INGRAM, S.	County Surveyor, Devon. Exeter.
1888 Nov. 17	IRVING, W. E.	Surveyor, Toowong, Queensland, Australia.
1893 June 24 B1902 Nov. 8	ISAACS, L. H., A. Inst. C.E. ..	3 Verulam Buildings, Gray's Inn, W.C.
1904 May 28	IVESON, J. A...	Surveyor to the Rural District Council, 2 Nares Street, Scarborough.
1900 July 19	JACK, G. H.	Surveyor to the Urban District Council, Aston Manor.
1893 Oct. 21	JAFFREY, W.	Town Surveyor, Matlock Bath.
1896 Oct. 24	JAMES, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
1903 Dec. 12	JAMES, C. C., M.Inst.C.E. ..	The Ministry, P.W.D., Cairo. 28 Victoria Street, S.W.
G1887 Oct. 22 T1890 Mar. 29	*JAMESON, M. W., A. M.Inst. C.E.	Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	JARVIS, R. W.	Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	JEEVES, E.	Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 T1903 Oct. 17	*JEFFES, R. H.	Surveyor to the Urban District Council, Cheshunt.
G1896 Jan. 18 T1896 Oct. 24	*JENKIN, C. J., A.M. Inst.C.E.	Surveyor to the Urban District Council, Finchley, N.
1899 June 10	JENKINS, D. M., A.M.Inst.C.E.	Borough Surveyor, Neath.
1880 Feb. 7	JENNINGS, G...	Borough Surveyor, Rotherham.
1895 May 25	JEPSON, J.	Surveyor to the Urban District Council, Levenshulme.
1892 July 21	JEVONS, J. H., A.M. Inst. C.E.	Borough Surveyor, Hertford.
1904 May 28	JOHNSON, J.	Borough Surveyor, Rawtenstall.
1895 June 27	JOHNSTON, J., M. Inst. C.E.	Waterworks Engineer, Brighton.
1883 Aug. 4 B1902 Nov. 8	JONES, U.C., Lt.-Col. A. S., M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
1873 Feb. 15	JONES, CHAS., M. Inst. C.E. *(Past President and Gen. Hon. Secretary. Member of Council.)*	Borough Surveyor, Ealing, Middlesex.
1894 July 7	JONES, CHRISTOPHER	Borough Surveyor, Hythe, Kent.
G1903 May 16 T1904 June 26	*JONES, F. W...	Surveyor to the Urban District Council, Frome, Somerset.

Date of Election and Transfer.		
1874 Jan. 29	Jones, I. M., M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
1894 June 21	Jones, J.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
1894 June 21	Jones, J. O.	Surveyor to the Rural District Council. Biggleswade.
1903 June 6	Jones, R. R.	Surveyor to the Urban District Council, Horsforth.
1900 Mar. 10	Jones, T. C.	Surveyor to the Urban District Council, Frimley. Camberley, Surrey.
1892 May 28	Jones, W., Assoc.M.Inst.C.E. (*Member of Council.*)	Surveyor to the Urban District Council. Colwyn Bay. *Hon. Sec.*, North Wales District.
1897 Feb. 13	Jones, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	Jones, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1906 Dec. 15	Joyce, T. W...	Engineer and Surveyor to the Urban District Council, Redruth.
1891 June 25	Jukes, W. H.	Surveyor to the Urban District Council, Tipton.
1905 Oct. 28	*Kay, G. H.	Surveyor to the Urban District Council, Irlam, Lancs.
1895 July 27 T1899 Dec. 16	Kay, W. B., A.M. Inst. C.E.	Athol Street, Douglas, Isle of Man.
P1889 Feb. 9	Kemp, J., Assoc. M. Inst. C.E.	Engineer to the Municipality of Brisbane, Queensland.
1892 Apr. 23	Kennedy, J. D.	Borough Surveyor, Retford.
1905 Jan. 28	*Kenyon, L.	Surveyor to the Urban District Council, Tottington.
1895 May 25	Keywood, H. G.	Surveyor to the Urban District Council, Hoyland Nether, Barnsley.
1892 July 11	Kidd, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
1899 Oct. 21	Killick, J. S.	Highway Surveyor to the Rural District Council, Croydon.
1899 June 29	Killick, P. G.	Borough Surveyor, Finsbury, E.C.
1902 May 10 T1903 July 25	Kinnison, A. M.	Abbey Cottage, Leek, Staffs.
1888 Sept. 15	Kirk, T., Assoc. M. Inst. C.E.	Town Engineer, Ipswich, Queensland.
1892 Mar. 11	Kirkby, S. A., M.A., Assoc. M. Inst. C.E.	County Surveyor, Cork (South division), East Riding. Miramur, Queenstown.
1895 Oct. 19	Knapp, R. W.	Borough Surveyor, Andover.
1903 June 25	*Knewstubb, F. W., A.M.Inst. C.E.	Surveyor to the Urban District Council, Haverhill.
1903 June 25	*Knewstubb, J. J.	Surveyor to the Urban District Council, Penrith.
1894 Mar. 3 T1903 Jan. 17	Knight, J. M., A.M.Inst.C.E.	35 Bancroft Road, Mile End, E.

Date of Election and Transfer.		
1884 Oct. 9	Lacey, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*Lacey, G. W.	Borough Surveyor, Oswestry.
1882 May 25 B1902 Jan. 25	Laffan, G. B., M. Inst. C.E.	Hardy's Chambers, Pietermaritzburg.
1900 Dec. 15	Lailey, H. G. N.	Surveyor to the Urban District Council, Trowbridge.
1900 July 19	Laithwaite, V.	Surveyor to the Urban District Council, Turton.
1904 Apr. 30	Lambert, A. P.	P.W.D., Winchester House, Johannesburg, South Africa.
A1902 Mar. 29 T1905 Oct. 28	Lancashire, W. T., Assoc. M.Inst. C.E.	City Engineer, Leeds.
1904 Oct. 13	Landale, G.	Burgh Surveyor, Musselburgh, N.B.
1891 June 6	Landless, J. T., Assoc. M. Inst. C.E.	4 Nicholas Street, Burnley.
1904 Aug. 25	Lawrie, J. P.	Burgh Surveyor, Bo'ness, N.B.
1884 July 10	Lawson, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1900 Mar. 10	Lawton, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
G1899 Oct. 21 T1901 May 11	*Lea, M., A. M. Inst. C.E. ..	City Surveyor, Truro.
1904 Aug. 31	Lee, J.	Burgh Surveyor, Paisley, N.B.
1896 Oct. 24	Leebody, J. W.	County Surveyor, Co. Tyrone (S.).
1898 Mar. 19	Leete, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	Leete, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1900 May 19	Legg, E. I.	Borough Surveyor, Christchurch, Hants.
1894 May 19	Leigh, W.	Borough Surveyor, Chorley.
1873 Feb. 15	LEMON, J., M. Inst. C.E. (*Past President.*)	Lansdowne House, Southampton; and 11 Victoria Street, Westminster, S.W.
1899 Oct. 21	Lines, E.	Engineer to the Rural District Council, Chesterfield.
G1896 July 25 T1899 Dec. 16 B1903 Feb. 21	*Liversedge, J. W.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1891 Mar. 21 B1901 Aug. 24	Livingstone, G., Assoc. M. Inst. C.E.	216 Church Road, Hove.
G1895 May 25 T1900 Oct. 15	*Lobley, F. J., A.M.Inst.C.E.	City Surveyor, Chichester.
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President. Member of Council.*)	Borough Engineer, Hanley, Staffordshire.
1896 June 25	Locke, W. R.	Borough Surveyor, Town Hall, Hemel Hempstead.
1889 Sept. 21	Lomax, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1904 Mar. 26	Longdin, H. W.	Surveyor to the Urban District Council, Penge.
1896 Oct. 24	Longfield, R. W. F., M. Inst. C.E.	County Surveyor, Co. Cork (W.). Bandon.
1903 Dec. 12	Longley, H. B.	District Surveyor, Town Hall, Manchester.

Date of Election and Transfer.		
1902 Nov. 8	Lord, E. I.	Borough Engineer, Greymouth, New Zealand.
1901 May 11	Loveday, W. F.	Borough Surveyor, Stoke Newington, N.
1892 Jan. 16	Lovegrove, E. J., M. Inst. C.E.	Borough Engineer, Hornsey, N.
1897 July 8	Lumsden, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	Lund, C.	Surveyor to the Urban District Council, Cleckheaton.
1896 Oct. 24	Lynam, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.).
G1888 July 12 T1897 Oct. 16	*Lynam, G. T., Assoc.M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1891 Aug. 1	Lynam, P. J.	County Surveyor, Louth. Dundalk. Ireland.
1873 May 2 R1900 Mar. 10	McBeath, A. G., Assoc. M. Inst. C.E.	Montagu Road, Sale, Cheshire.
1905 Mar. 3	McBeth, M. B.	Surveyor to Mid-Argyll District, Argyllshire County Council. Kilmory Cottage, Lochgilphead, Argyllshire.
1883 May 30	MacBrair, R. A., M.Inst.C.E.	City Engineer, Lincoln.
1904 Aug. 24	McBride, S.	Burgh Surveyor, Rutherglen, N.B.
1900 Feb. 10	McDermid, C.	Surveyor to the Urban District Council, Eston.
1897 Feb. 13	McDonald, A. B., M. Inst. C.E. (*Member of Council.*)	City Engineer, Glasgow.
1904 Oct. 29	MacGregor, J. M.	Highway Surveyor to the Rural District Council, 33 Bridge Street, Morpeth.
1897 Jan. 16	MacKenzie, D.	County Surveyor, Dunfermline.
1895 Oct. 19	McKenzie, J. McD.	Surveyor to the Rural District Council, Bucklow. Mossburn Bldgs., Stamford New Road, Altrincham.
1904 Oct. 1	Mackie, G. D.	Water Engineer, Municipal Buildings, Clydebank, N.B.
1879 Oct. 23 R1889 Oct. 19	McKie, H. U., M. Inst. C.E.	The White House, Spondon, Derby.
1898 June 30	McKillop, R.	Burgh Surveyor, Perth, N.B.
1906 Mar. 3	*Maden, J.	Borough Engineer, King Williamstown, S. Africa.
1898 Feb. 19	Madin, W. B.	Surveyor to the Urban District Council, Rushden.
1897 Mar. 13	Mager, F. W., Assoc.M. Inst. C.E.	P. W. D. Kuala, Lumpur, Selangor, S. Settlements.
1886 Dec. 18	Mair, H., M. Inst. C.E. ..	Borough Engineer, Hammersmith, W.
1900 Feb. 10	Mallinson, J.	Surveyor to the Urban District Council, Skipton.
G1891 Jan. 21 T1897 June 19 R1904 Jan. 23	*Manley, J.	7 Oxford Road, Wokingham.
1892 July 21	Manning, G. W.	Surveyor to the Rural District Council, Staines.
G1898 Jan. 15 T1901 Aug. 24	*Marks, C. W...	Borough Surveyor, Wokingham.

Date of Election and Transfer.		
1888 July 12	MARKS, H. C., M. Inst. C.E.	City Surveyor, Carlisle.
1899 May 6	MARKS, W. L.	Surveyor to the Urban District Council, Rhymney.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Rural District Council, West Malling.
1891 Jan. 21 / R1902 Nov. 8	MARSTON, C. F., Assoc. M. Inst. C.E.	Masonic Hall Chambers, Mill Street, Sutton Coldfield.
1894 Mar. 3	MARTEN, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Eastern District, Wandsworth. 215 High Road, Balham, S.W.
1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1904 Oct. 22	MASSIE, C.	Water Engineer, Falkirk, N.B.
1890 Mar. 29	MASSIE, F., M. Inst. C.E. ..	Surveyor to the Rural District Council, Wakefield.
1904 Aug. 17	MASSIE, J.	Burgh Engineer, Edinburgh, N.B.
1906 Apr. 28	MATHER, H. T.	Surveyor to the Urban District Council, Surbiton.
1883 Feb. 17	MATHEWS, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
1898 Dec. 17	*MATTHEWS, E. R., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bridlington.
1904 May 28	MAUDSLEY, C. W...	Surveyor to the Rural District Council, Oakham, Rutland.
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*)	Borough Engineer, Leicester.
1892 Mar. 11	MAWSON, R. O.	Borough Surveyor, Evesham.
G1896 July 25 / T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C E.	Borough Surveyor, Tunbridge Wells.
G1898 Dec. 17 / T1904 June 26	*MAY, C. G.	Superintendent of Works and Surveys, P.W.D., Singapore.
1894 Oct. 20	MAYBURY, H. P.	County Surveyor, Maidstone.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	Engineer and Surveyor to the Municipal Council, Shanghai. *Hon. Corresponding Sec.* for Eastern Asia
1883 Feb. 17	MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester.
1888 July 12	*METCALF, J. W., Assoc. M. Inst. C.E.	Town Surveyor, Newmarket.
1903 June 25	*METCALFE, A. J.	Surveyor to the Rural District Council, Bourne.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
1874 May 23	MITCHELL, J...	Borough Surveyor, Hyde, Manchester.
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, County Buildings, Stafford.
1900 Dec. 15	MONTEATH, G.	County Surveyor, Newtown, St. Boswell's, N.B.

Date of Election and Transfer.		
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
1905 Oct. 28	MORLEY, E.	Surveyor to the Urban District Council, Walthamstow.
1903 Feb. 21	MOULDING, T., A.M.Inst.C.E.	City Surveyor, Exeter.
A1902 Jan. 25 T1902 June 7	*MOUNT, J. C., A.M. Inst. C.E.	Borough Surveyor, Lancaster.
1885 Feb. 7 R1905 Jan. 28	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	14 Prince's Chambers, 16 John Dalton Street, Manchester.
1898 Sept. 3	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Athlone.
1890 Mar. 29	MURCH, P.	Borough Engineer, Portsmouth.
1896 Nov. 28	MURPHY, P. E., M.Inst. C.E.	Engineer to the Tottenham and Wood Green Joint Drainage Committee. Council Buildings, Tottenham, N.
1904 Aug. 6	MURRAY, J.	County Surveyor, Renfrewshire. Paisley, N.B.
1904 Aug. 17	MURRAY, J.	Burgh Surveyor, Port Glasgow, N.B.
1895 Feb. 16 R1904 Jan. 23	MURZBAN, KHAN BAHADUR M. C., C.I.E., M. Inst. C.E.	"Gulestan," Murzban Road, Bombay.
1896 Oct. 24	NANKIVELL, H. H.	Surveyor to the Urban District Council, Braintree.
G1903 Oct. 17 T1905 May 27	*NASH, F. O. C., Assoc. M.Inst. C.E.	Surveyor to the Urban District Council, Cockermouth.
1905 Oct. 28	NELSON, G., A.M.Inst. C.E.	Surveyor to the Urban District Council, Gosforth.
1893 July 31	*NETTLETON, H., Assoc. M. Inst C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
1897 July 8	NEWMAN, S. J.	Borough Surveyor, Poole.
1906 Sept. 22	NEWTON, A. W.	Surveyor to the Hutt County Council, Wellington, N.Z.
1897 Feb. 13 R1903 Jan. 17	NEWTON, C. E.	19 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*NEWTON, E. B., A.M. Inst. C.E.	Borough Surveyor, Paddington, W.
1891 Oct. 17	NEWTON, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
1888 May 12	NEWTON, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*NICHOLS, A. E., A.M. Inst.C.E.	Borough Engineer, Folkestone.
1904 Aug. 5	NISBET, T., Assoc. M.Inst.C.E.	Master of Works, City Chambers, Glasgow, N.B.
1887 July 14 R1899 Feb. 25	NORRINGTON, J. P., Assoc. M. Inst. C.E.	28 Dulwich Road, Brixton, S.E.

Date of Election and Transfer.		
G1897 Mar. 13 T1898 Sept. 3	*NORRIS, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18 B1901 May 11	NORRISH, G. R.	Hawley House, Tudor Road, Upper Norwood.
1900 Dec. 15	NUTTALL, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Kearsley.
1899 Feb. 25	NUTTALL, W.	Surveyor, Prestwich.
G1898 June 30 T1899 Oct. 21	*OAKDEN, R., A.M. Inst. C.E. ..	Surveyor to the Rural District Council, Newark.
A1902 Jan. 25 T1906 Nov. 3	OAKES, H. H.	Town Surveyor, Ventnor, I. of W.
1901 Aug. 24	O'HARA, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1892 Jan. 16	OXTOBY, W., M. Inst. C.E. ..	Borough Engineer, Camberwell, S.E.
1896 Apr. 25	PALMER, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
PP1900 Mar. 10	PALMER, P. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Hastings.
1905 Jan. 28	PANSING, J., A.M. Inst. C.E.I.	Town Surveyor, Wicklow.
1894 Apr. 6	PARDOE, J. C., Assoc. M. Inst. C.E	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	PARKER, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.
1887 July 14 B1895 June 27	PARKER, J., A.M. Inst. C.E.	49 Denmark Villas, Hove, Brighton.
1896 Nov. 28 B1903 Feb. 21	PARKER, J. E., A.M.Inst.C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	PARKER, S. W.	Surveyor to the Urban District Council, Gainsborough.
1893 July 13	PARR, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
G1898 June 30 T1899 Oct. 21	*PARR, F. H.	Borough Surveyor, Lymington.
G1893 Jan. 14 T1894 Oct. 20	*PARR, N.	Surveyor to the Urban District Council, Brentford.
1905 June 22	*PARRY, E.	Divisional Surveyor, Herts County Council, 24 Lancaster Road, Hitchin.
P1894 June 21	PATON, J. (*Member of Council.*)	Borough Engineer, Plymouth.
1905 June 22	PATTINSON, N. P.	Borough Surveyor, Gateshead.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	PEACOCK, T. J.	Surveyor to the Rural District Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1899 Oct. 21	PEET, H. F., M. Inst. C.E.	City Engineer, Bloemfontein, South Africa.
1891 Dec. 12	PEIRCE, R., M. Inst. C.E. ..	Municipal Engineer, Singapore, S.S.

Date of Election and Transfer.		
A1902 Mar. 22 T1906 Dec. 15	PHILLIPS, G. A., A.M.Inst.C.E.	County Surveyor, Glamorgan.
1889 May 18	PHILLIPS, R., Assoc. M. Inst. C.E.	County Surveyor, Gloucester.
1904 May 28	PHIPPS, F. R., Assoc.M. Inst. C.E.	Borough Surveyor, Basingstoke.
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester. 6 Millstone Lane, Leicester.
1901 Oct. 19	PICKARD, J. E.	Borough Surveyor, Pontefract, Yorks.
1898 Apr. 23	PICKER, E.	Surveyor to the Rural District Council, Beverley.
G1887 June 18 PPT1890 Sept. 13	*PICKERING, J. S., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Cheltenham. *Hon. Secretary*, Western District.
1881 Dec. 10 R1884 May 29	PICKERING, R.	11 Lowther Street, Whitehaven.
G1894 Jan. 13 T1895 Oct. 19	*PICKLES, G. H., A.M.Inst.C.E.	Borough Surveyor, Burnley.
1906 Mar. 3	PICTON, T. S...	Borough Engineer, Eccles.
P1881 Dec. 10	PLATT, S. S., M. Inst. C.E.	Borough Surveyor, Rochdale.
1893 Oct. 21	PLOWRIGHT, A. H...	2 Bury Strret, Norwich.
1884 Mar. 15 R1885 Oct. 3	POLLARD, J., M. Inst. C.E. ..	31 Old Queen Street, Westminster, S.W.
1897 July 8	POOLE, H. C.	Surveyor to the Urban District Council, Wath-upon-Dearn.
1881 July 7	PORTER, R.	Borough Surveyor, Wakefield.
1899 Oct. 21	*PRESCOTT, A. E.	Borough Surveyor, Eastbourne.
1898 Mar. 19	PRESCOTT, W. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Tottenham, N.
1892 Jan. 16	PRESS, W. J.	Surveyor, Burnham, Somerset.
G1894 June 21 T1899 June 29	*PRICE, A. J.	Surveyor to the Urban District Council, Lytham.
1904 Sept. 29	PRITTY, J.	Burgh Engineer, Selkirk, N.B.
1873 May 2	PROCTOR, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1892 May 28	PROUSE, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1904 Aug. 4	PURDIE, W. H.	Burgh Engineer, Hamilton, N.B.
1873 May 2	PURNELL, E. J.	Water Engineer, Coventry, Warwickshire.
1899 May 6	PURSER, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council. Grantham.
G1893 July 31 T1898 June 13	*PUTMAN, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1905 Dec. 9	PUTTEN, E. VAN, M.Inst.C.E.	Borough Engineer, Lewisham, Town Hall, Catford, S.E.
1886 Dec. 18 R1901 Oct. 19	RADFORD, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.
1889 July 4	RAPLEY, W.	Surveyor to the Rural District Council, Dorking.
1898 Apr. 23	RAYNER, F. J.	Surveyor to the Urban District Council, Newhaven.

Date of Election and Transfer.		
1878 May 1	READ, R., A.M. Inst. C.E. .. (*Member of Council.*)	City Surveyor, Gloucester.
G1897 June 19 TA1901 Dec. 7 T1904 Sept. 17	*REDFERN, J. L.	Borough Surveyor, Gillingham, Kent.
1898 Dec. 17	REID, R. M.	Highway Surveyor to the Stirlingshire County Council, Barnsdale House, Whins of Milton.
1897 Feb. 13	RENWICK, R.	Surveyor to the Urban District Council, Horsham.
1892 Mar. 11	REYNOLDS, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
1888 July 12 R1902 Feb. 22	RICHARDS, R. W., M. Inst. C.E.	Town Clerk, Dunedin, New Zealand. *Hon. Corresponding Secretary* for Australasia.
1888 May 12	RICHARDSON, H., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Handsworth, Birmingham. *Hon. Secretary*, Midland District.
1884 Oct. 9	RICHARDSON, J.	County Surveyor, Rutland. Stamford.
1901 May 11	*RIDLER, W.	Borough Surveyor, Tewkesbury.
1892 Mar. 11	RIDOUT, A. R.	Surveyor to the Urban District Council, Stone.
G1901 Aug. 24 TA1905 Dec. 9 T1906 June 28	*RILEY, J.	Town Surveyor, Germiston, Transvaal, South Africa.
G1891 Dec. 12 T1897 Mar. 13	*ROBERTS, F., A. M. Inst.C.E.	Borough Engineer, Worthing.
1891 Oct. 17	ROBINSON, W. P., A.M. Inst. C.E.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
1886 May 1	ROBINSON, W. J.	City Surveyor, Londonderry.
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President. Member of Council.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1906 Sept. 22	ROGERS, S. G.	Borough Engineer, Chard.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1904 Oct. 22	RONALD, D.	Burgh Engineer, Falkirk, N.B.
1895 Jan. 19	ROSS, J. C., A.M. Inst. C.E. ..	Engineer of Water Supply, City Hall, Toowoomba, Queensland, Australia.
G1901 Feb. 16 T1905 Mar. 3	*ROTHERA, A.	Surveyor to the Urban District Council, Thornhill, near Dewsbury.
1880 Oct. 2 R1905 May 27	ROUNTHWAITE, R. S., M. Inst. C.E.	3 Willis Street, Wellington, New Zealand.
1888 May 12	RUCK, F. W.	County Architect, 86 Week Street, Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	Surveyor to the Urban District Council, Cleethorpes.
A1903 Mar. 21 T1904 Sept. 17	RYMAN, F. R., A.M.Inst.C.E.	Borough Surveyor, Stamford.

Date of Election and Transfer.		
1890 Mar. 29 B1904 Mar. 26	*Saise, A. J., Assoc. M. Inst. C.E.	Eagle Insurance Buildings, Baldwin Street, Bristol.
1899 Feb. 25	Salkield, T.	Chief Engineer to Municipality of Delhi, India.
A1903 June 25 T1906 Dec. 15	*Saunders, E. Y.	Borough Surveyor, Barnstaple.
G1887 June 18 T1898 May 21 B1903 Mar. 21	*Saunders, J., A.M. Inst. C.E.	Imperial Chambers, Newark.
1894 Mar. 3	Saville, J.	Town Surveyor, Heckmondwike.
1899 May 6	Schofield, W. H., A.M. Inst. C.E.	County Surveyor, Lancashire. County Hall, Preston.
1894 June 21	Scorgie, N., M. Inst. C.E. ..	Boro' Surveyor, Hackney, N.E.
1892 Sept. 24	Scott, A. F.	Surveyor to the Urban District Council, Cromer.
1888 Nov. 17	Scott, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.
1901 Aug. 24	Scott, J. H.	Surveyor to the Urban District Council, Winton, Bournemouth.
1880 May 27	Scott, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	Scott, T.	Surveyor to the Rural District Council, Tadcaster, Aberford, near Leeds.
1904 Aug. 4	Scott, T. H	Burgh Surveyor, Inverness, N.B.
1897 July 8	Senior, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
1896 Oct. 24	Senior, J. S.	Surveyor to the Urban District Council, Swanage.
G1894 July 7 T1898 Mar. 19	*Settle, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Heywood, Manchester.
1873 May 2 B1903 May 16	Sharman, E.	Croyland Abbey, Wellingborough, Northamptonshire.
1896 Nov. 28	Sharpe, J. E.	Surveyor to the Urban District Council, Otley, Yorks.
1891 June 6	Shaw, H., Assoc.M.Inst.C.E.	Surveyor to the Urban District Council, Ilford.
1890 June 7 B1901 Aug. 24	Shaw, J. H.	Shenstone Cottage, Brownhills, Staffs.
1892 May 28	Sheard, W. C., Assoc.M. Inst. C.E.	"Stonelea," Newtown, New Mills, near Stockport.
1905 June 22	Shell, W. S.	Surveyor to the Urban District Council, Consett, Durham.
1891 Oct. 17	Shepherd, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	Sheppard, G.	Borough Surveyor, Newark.
1892 July 11	Shillington, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	Shipton, T. H.	Surveyor to the Urban District Council, Oldbury.
1902 June 7	Siddalls, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	Siddons, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	Sidwell, H. T.	Surveyor to the Rural District Council, Rochford, Essex.

Date of Election and Transfer.		
P1887 July 14 R1898 Oct. 15	*SILCOCK, E. J., M. Inst. C.E.	10 Park Row, Leeds.
1897 Mar. 13	SILCOCK, H.	Surveyor to the Rural District Council, Blackwell. 67 Westgate, Mansfield.
1903 Oct. 17	SIMMONDS, T. B.	Surveyor to the Urban District Council, New Malden.
1904 May 28	*SIMMONS, R.	Surveyor to the Urban District Council. Little Woolton, near Liverpool.
1901 Feb. 16	SIMPSON, H. FARR	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1891 Aug. 1 R1895 June 27	SIMPSON, W. H., A. M. Inst. C.E.	Horsefair Street, Leicester.
1906 Dec. 15	SIMS, A.	Surveyor to the Rural District Council, Ashford
1890 Sept. 13	SINCLAIR, J. S., A.M. Inst.C.E.	Borough Surveyor, Widnes.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
1899 Oct. 21	SLOCOMBE, D. W.	Surveyor to the Urban District Council, Brynmawr.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E...	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S W.
1898 June 30	SMALES, J. E...	Surveyor to the Urban District Council, Leatherhead
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
1892 Mar. 11	SMITH, C. CHAMBERS	Surveyor to the Urban District Council, Sutton, Surrey.
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.
G1904 May 28 T1904 Sept. 17	*SMITH, F. HALL	Surveyor to the Urban District Council, Swaffham.
1899 Mar. 25	SMITH, H. W., A.M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Scarborough. *Hon. Secretary*, Yorkshire District.
1892 Mar. 11	SMITH, J., B.E., M. Inst. C.E.	County Surveyor, Co. Galway (E. Riding), Ballinasloe.
1897 May 15	SMITH, JAMES..	Borough Surveyor, Buckingham.
1895 May 25	SMITH, J. B.	Surveyor to the Urban District Council, Tyldesley
1899 Oct. 21	SMITH, J. D.	County Surveyor's Office, Dalbeattie, Kirkcudbrightshire.
1901 Dec. 7	SMITH, J. GOULD, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1905 Jan. 28	*SMITH, J. H. W.	Surveyor to the Urban District Council, Minehead.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*SMITH, J. WALKER	Borough Surveyor, Barrow-in-Furness.
1904 Aug. 6	SMITH, P. C.	Burgh Surveyor, Arbroath, N.B.
1891 Dec. 12	SMITH, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	SMITH, V.	Borough Surveyor, Chesterfield.
G1888 Jan. 14 T1897 Mar. 13	*SMITH-SAVILLE, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
1898 Jan. 15	SNELL, J. F. C., M.Inst.C.E.	Borough Electrical Engineer, Sunderland.
1903 Oct. 17	SOWDEN, M.	Surveyor to the Urban District Council, Whitchurch, Salop.

Date of Election and Transfer.		
1898 Dec. 17	SPENCER, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 B1881 Dec. 10	SPENCER, J. P., A.M.Inst.C.E.	30 Howard Street, North Shields.
1902 May 10	SPENCER, L. G. P., A.M. Inst. C.E.	Borough Engineer, Inglewood, New Zealand.
P1885 June 25 B1888 Sept. 15	SPINKS, W., M. Inst.C.E. ..	39 Prudential Assurance Buildings, Park Row, Leeds.
G1899 Dec. 16 TA1901 Oct. 19 T1904 July 14	*SPRECKLEY, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Ludlow.
A1904 May 28 T1906 Nov. 3	SPURRELL, E. F.	Borough Surveyor, Holborn.
1880 Feb. 7 B1899 June 10	STAINTHORPE, T.W., A.M.Inst. C.E	P.W.D., Cape Town, South Africa.
1889 Dec. 14	STALLARD, S., A.M. Inst. C.E.	County Surveyor, Oxfordshire. Oxford.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1890 Mar. 29	STEVENS, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
1892 Mar. 11	STEVENSON, A.	District Surveyor, Ayrshire County Council.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb. 16	STEWART, J.	Borough Engineer, Dunstable, Beds.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., M. Inst. C.E.	City Engineer, Birmingham.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1904 Jan. 23	*STONES, J.	Surveyor to the Rural District Council, Sedgfield, co. Durham.
1898 Mar. 19	STOW, J. F.	Surveyor to the Rural District Council, Uxbridge.
1903 Mar. 11	STREATHER, W. T.	Surveyor to the Urban District Council, Waltham Cross.
G1893 June 24 T1893 July 13	*STRINGFELLOW, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ashbourne, Derbyshire.
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., M. Inst. C.E. ..	City Engineer, Guildhall, London, E.C
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
1904 Aug. 10	SUTHERLAND, J. R., A.M.Inst. C.E.	Chief Engineer, Water Department, City Chambers, Glasgow, N.B.
G1899 June 29 T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon.
1880 June 23 B1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton-on-Tees.

Date of Election and Transfer.		
G1902 Feb. 22 TA1904 Dec. 3 T1906 Nov. 3	*TAIT, W. I.	Borough Engineer, Sudbury, Suffolk.
1887 Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1895 Mar. 16	TARBIT, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
1891 Mar. 21 R1903 Mar. 21	TAYLOR, H. W., Assoc. M. Inst. C.E.	St. Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
1890 Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
G1891 Sept. 12 T1897 Oct. 16	*TAYLOR, W. J., M. Inst. C.E.	County Surveyor, Hants. Winchester.
1892 Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
1892 Mar. 11	*THOMAS, R. J., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Bucks. Aylesbury. *Hon. Secretary*, Home District.
1890 May 3	THOMAS, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902 May 10	THOMAS, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887 Sept. 17	THOMAS, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath: *Hon. Secretary*, South Wales District.
1906 Nov. 3	THOMSON, J.	City Engineer, Dundee.
G1904 June 25 T1906 Nov. 3	THORP, W. O.	Surveyor to the Urban District Council, Malvern.,
1891 Jan. 21	THORPE, J.	Surveyor to the Rural District Council, Macclesfield.
1898 Jan. 15	THROPP, J., M. Inst. C.E.	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
1898 Apr. 23	THWAITES, W., M. Inst. C.E.	Chief Engineer to the Metropolitan Board of Works, Melbourne, Australia.
G1898 June 30 T1903 Dec. 12	*TIFFIN, T. E., A.M.Inst.C.E.	Surveyor to the Urban District Council, Dartford, Kent.
G1891 June 6 T1893 Oct. 21	*TOMES, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
1895 Mar. 16	TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
1890 May 3	TOWLSON, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
1894 Oct. 20	TRAVERS, W. H.	Surveyor to the Urban District Council, Wallasey.
1897 Jan. 16	TRESIDDER, W. H.	Borough Surveyor, Falmouth.
1901 Feb. 16	TROWSDALE, T. J.	Surveyor to the Urban District Council, Annfield Plain. Hare Law, Annfield Plain, Co. Durham.
1893 Oct. 21	TURLEY, A. C., Assoc.M.Inst. C.E.	City Engineer, Canterbury.
1890 Oct. 18	TURNBULL, A. J.	Burgh Surveyor, Greenock, N.B.
1897 Mar. 13	TURNER, H. H.	Surveyor to the Rural District Council, Limehurst, Lancs. 250 Oldham Road, Waterloo, near Ashton-under-Lyne.

Date of Election and Transfer.		
1899 June 10	*Turner, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	Turriff, A. A.	Burgh Surveyor, Elgin, N.B.
1905 May 27	*Uren, F. C.	Surveyor to the Urban District Council, Aldershot.
1889 Sept. 21	Vallance, B. F.	Borough Surveyor, Mansfield.
1887 Oct. 22	Valon, W. A. McIntosh, Assoc. M. Inst. C.E.	Ramsgate Corporation Gasworks Engineer. 140 and 141 Temple Chambers, Temple Avenue, E.C.
G1894 Jan. 18 T1901 Dec. 7 M1903 Feb. 21	*Veit, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 M1903 Jan. 17	Ventris, A., Assoc. M. Inst. C.E.	160 Buckingham Palace Road, S.W.
1897 June 19	Vincent, S. J. L., A. M. Inst. C.E.	Borough Surveyor, Newbury.
1894 June 21	Waddington, J. A. P., M. Inst. C.E.	Borough Engineer, Marylebone, W.
1902 June 7	Wakeford, J. P., A. M. Inst. C.E.	Surveyor to the Urban District Council, Bilston.
1888 July 12	Wakelam, H. T., M. Inst. C.E. (*Member of Council.*)	County Engineer, Middlesex. Guildhall, Westminster, S.W.
1898 Sept. 3	Walker, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.
G1900 Dec. 15 T1904 Jan. 23	*Walker, H.	Surveyor to the Urban District Council, Wealdstone.
P1873 May 2	Walker, T.	"Fieldhead," Harriotts Lane, Ashstead.
1887 June 18	Walshaw, J. W.	Borough Surveyor, Peterborough.
1905 Sept. 23	Warburton, W. E.	Surveyor to the Urban District Council, Hornsea.
1899 Jan. 21	Ward, J., M. Inst. C.E. ..	Borough Engineer, Derby.
1904 Jan. 23	Ward, T., Assoc. M. Inst. C.E.	Borough Engineer, Lower Hutt. 4 Grey Street, Wellington, New Zealand.
1886 July 8	Wardle, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
G1900 May 19 T1905 Mar. 3	*Warlow, W. R.	Surveyor to the Urban District Council, Milton-next-Sittingbourne.
G1904 May 28 T1904 Sept. 17	*Warr, G. W.	Surveyor to the Urban District Council, Southwick.
1890 May 3	Waterhouse, D.	Surveyor to the Urban District Council, Watford.
1892 Mar. 11	Watkeys, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.

Date of Election and Transfer.		
1887 June 18	WATSON, J. D., M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Council House, Birmingham.
1904 Aug. 10	WATSON, W.	Burgh Surveyor, St. Andrews, N.B.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1893 Oct. 21	WATTS, W., A.M.Inst. C.E. ..	Water Engineer, Langsett, near Penistone.
1887 June 18	WEAVER, W., M. Inst. C.E. (*Past President.*)	30 Lytton Grove, Putney Hill, S.W.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1905 Oct. 28	WEBB, J. H.	Borough Surveyor and Water Engineer, King's Lynn.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	WEBSTER, R. A.	Town Engineer, Krugersdorp, Transvaal, South Africa.
1895 May 25 B1901 Aug. 24	WEBSTER, R. J.	District Surveyor, Castleton, Manchester.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1887 June 18 B1903 Feb. 21	WESTON, G.	The Limes, Harrow Road, Pinner.
1889 Apr. 13 B1903 Jan. 17	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
P1888 July 12	WHITE, A. E., M. Inst. C.E. .. (*Member of Council.*)	City Engineer, Hull.
1891 Oct. 17	WHITE, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County, Maryborough.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
1899 Mar. 25	WHITTELL, F. S.	Surveyor to the Urban District Council, Worksop.
1900 Aug. 25	WHYATT, H. G., A. M. Inst. C.E.	Borough Engineer, Great Grimsby.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. (*Vice-President.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1905 June 22	WILES, J. W.	Surveyor to the Urban District Council, Gorton, Lancs.
1884 May 29 B1902 Nov. 8	WILKINSON, J. P., M. Inst. C.E.	301-304 Corn Exchange Chambers, Cathedral Street, Manchester.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1899 Feb. 25 B1903 Mar. 21	WILKINSON, W.	Ashton House, Hemingbrough, E. Yorks.

Date of Election and Transfer.		
1884 Oct. 9 R1885 June 6	WILLCOX, J. E., Assoc. M. Inst. C.E.	63 Temple Row, Birmingham.
1894 Mar. 3	WILLIAMS, H. DAWKIN	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
1904 May 28	WILLIAMS, J.	Surveyor to the Urban District Council, Abercarn, Mon.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
1897 May 15	WILLIAMS, M.	Surveyor to the Urban District Council, Bridgend.
1904 Aug. 4	WILLIAMSON, W.	City Engineer's Office, Glasgow.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1904 Oct. 29	WILLOUGHBY, P. R. A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Pontypridd.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
1887 Sept. 17	WILSON, G.	Surveyor to the Urban District Council, Alnwick.
1873 May 2 R1899 Feb. 25	WILSON, J.	Bankside, Bacup, Lancashire.
1884 May 29	*WILSON, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1904 Aug. 23	WILSON, J. R.	Burgh Surveyor, Helensburgh, N.B.
1897 Oct. 16	WINNING, D.	Burgh Surveyor, Broughty Ferry, N.B.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E.	Borough Surveyor, Hampstead, N.W.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*WOLFENDEN, B. J., A.M.Inst. C.E.	Borough Engineer, Bootle.
1880 Feb. 7	WOOD, A. R.	Surveyor to the Urban District Council, Tunstall.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
1898 Apr. 23	WOOD, W. E.	Surveyor to the Urban District Council, Church.
1900 Feb. 10	WOODS, E. L.	Town Surveyor, Bangor, Co. Down.
1885 Oct. 3 R1903 Feb. 21	WOODBRIDGE, C. A.	Pinner House, Pinner, Middlesex.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.
G1900 July 19 T1901 Oct. 19	*WOOTTON, A. S.	Surveyor, Urban District Council, Bradford-on-Avon.
1897 July 8	*WORRALL, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	WORTH, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.

Date of Election and Transfer.		
G1893 July 13 T1899 Oct. 21 B1904 Dec. 3	*Wright, J. A.	6 Unity Street, Bristol.
1892 May 28	Wynne-Roberts, R. O., M. Inst. C.E.	Water Engineer, Cape Town.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Bristol.
G1892 July 11 T1892 Sept. 24	*Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
1894 June 21	York, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1904 Aug. 26	Young, C.	Burgh Surveyor, Coatbridge, N.B.
1900 May 19	Young, J.	Burgh Surveyor, Ayr.
1899 Dec. 16	Young, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	Young, W. P...	Surveyor to the Rural District Council, Wallsall.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

A.	*signifies*	Abroad.	Met.	*signifies*	Metropolitan District.
Af.	„	African District.	M.	„	Midland District.
E.	„	Eastern District.	N.	„	Northern District.
H.	„	Home District.	S.	„	Scottish District.
Ind.	„	Indian District.	W.N.	„	Welsh District (North).
I.	„	Irish District.	W.S.	„	„ „ (South).
L. & C.	„	Lancashire & Cheshire District.	West.	„	Western District.
			Y.	„	Yorkshire District.

TOWN.	DISTRICT.	NAME.
Abercarn	West.	J. Williams.
Aberdeen	S.	W. Dyack.
Abergavenny	West.	J. Haigh.
Abingdon	H.	G. Winship.
Abram	L. & C.	G. Heaton.
Accrington	L. & C.	W. J. Newton.
Acton	H.	D. J. Ebbetts.
Aldershot	H.	F. C. Uren.
Alnwick	N.	G. Wilson.
Andover	H.	R. W. Knapp.
Annfield Plain	N.	T. J. Trowsdale.
Antrim (County)	I.	J. H. Brett.
Arbroath, N.B.	S.	P. C. Smith.
Argyllshire (County)	S.	M. B. McBeth.
Armagh	I.	J. C. Boyle.
„ (County)	I.	R. H. Dorman.
Ashbourne	M.	W. Stringfellow.
Ashby-de-la-Zouch	M.	S. Turner.
Ashford	H.	W. Terrill.
„ (Rural)	H.	A. Sims.
Ashton-under-Lyne	L. & C.	J. T. Earnshaw.
Ashton-on-Mersey	L. & C.	F. Hutton.
Aston Manor	M.	G. H. Jack.
Atherstone (Rural)	M.	H. J. Coleby.
Atherton	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
Athlone (County)	I.	C. J. Mulvany.
Auckland, New Zealand	A.	W. E. Bush.
Audley	M.	T. Bibbey.
Ayr	S.	J. Young.
Ayrshire (County)	S.	A. Stevenson.
Balby with Hexthorpe	Y	G. Gledhill.
Ballymena	I.	H. O'Hara.
Banbury	H.	N. H. Dawson.
Bangor, Co. Down	I.	E. L. Woods.
Barking	H.	C. F. Dawson.
Barnes	H.	G. B. Tomes.
Barnstaple	West.	E. Y. Saunders.

TOWN.	DISTRICT.	NAME.
Barrow-in-Furness	L. & C.	J. W. Smith.
Barry	W.S.	J. C. Pardoe.
Barton-upon-Irwell (Rural) ..	L. & C.	C. C. Hooley.
Basford (Rural)	M.	S. Maylan.
„ „ (Highways) ..	M.	G. W. Hawley.
Basingstoke	H.	F. R. Phipps.
Battersea	Met.	T. W. A. Hayward.
Beccles	E.	T. O. Cudbird.
Beckenham	H.	J. A. Angell.
Bedford	H.	N. Greenshields.
Bedford (County)	H.	W. H. Leete.
Belfast	I.	H. A. Cutler.
Belper	M.	T. Fenn.
„ (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Berkshire (County)	H.	J. F. Hawkins.
Bermondsey	Met.	R. J. Angel.
Berwick-on-Tweed	S.	R. Dickinson.
Berwickshire (County), N.B. ..	S.	T. R. Atkinson.
Bethnal Green	Met.	E. E. Finch.
Beverley	Y.	J. G. Smith.
„ (Rural)..	Y.	E. Picker.
Bexhill	H.	G. Ball.
Bexley	H.	W. T. Howse.
Biddulph	M.	S. Gibson.
Biggleswade	H.	T. Cockrill.
„ (Rural)	H.	J. O. Jones.
Bilston	M.	J. P. Wakeford.
Bingley	Y.	H. Bottomley.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	H. E. Stilgoe.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
Blackburn	L. & C.	W. Stubbs.
Blackpool	L. & C.	J. S. Brodie.
Blackwell (Rural)	M.	H. Silcock.
Bloemfontein, South Africa ..	Af.	H. F. Peet.
Blyth and Cuckney (Rural) ..	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bombay	Ind.	J Hall.
Bo'ness, N.B.	S.	J. P. Lawrie.
Bootle	L. & C.	B. J. Wolfenden.
Boston, Lincs.	E.	G. E. Clarke.
Bourne (Rural)	E.	A. J. Metcalfe.
Bournemouth	H.	F. W. Lacey.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West.	A. S. Wootton.
Braintree	E.	H. H. Nankivell.
Brecon	W.	H. Ll. Griffiths.
Brentford	H.	N. Parr.
Bridgend	W.S.	M. Williams.
Bridgwater	West.	F. Parr.
Bridgwater (Rural)	West.	W. A. Collins.
Bridlington	Y.	E. R. Matthews.
„ (Rural)	Y.	S. Dyer.
Brierfield	L. & C.	B. Halstead.
Brierley Hill	M.	J. L. Harpur.
Brighouse	Y.	S. S. Haywood.
Brisbane, Queensland	A.	J. Kemp.

TOWN.	DISTRICT.	NAME.
Bristol	West.	T. H. Yabbicom.
Briton Ferry	W.S.	H. A. Clarke.
Broadstairs	H.	H. Hurd.
Bromyard	M.	J. D. Barrs.
Broughty Ferry, N.B.	S.	D. Winning.
Brownhills	M.	W. B. Chancellor.
Brynmawr	W.S.	D. W. Slocombe.
Buckhurst Hill	E.	H. Tooley.
Buckingham	H.	J. Smith.
" (County)	H.	R. J. Thomas.
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West.	W. H. Chowins.
Burnley	L. & C.	G. H. Pickles.
" (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T Lynam.
Bury	L. & C.	A. W. Bradley.
Bury St. Edmunds	E.	W. D. Harding.
Buxton	M.	W. H. Grieves.
Caerphilly	W.S.	A. O. Harpur.
Camberwell	Met.	W. Oxtoby.
Cannock, Staffs	M.	J. S. Hendry.
Canterbury	H.	A. C. Turley.
Cape Town, South Africa	Af.	J. Cook.
Cardiff	W.S.	W. Harpur.
Carlisle	N.	H. C. Marks.
Carlton	M.	J. C. Haller.
Carmarthen	W.S.	F. J. Finglah.
Carnarvonshire (County)	W.N.	E. Evans.
"	W.N.	E. Hall.
Castleford	Y.	W. Green.
Chatham	H.	C. Day.
Chelmsford	E.	C. Brown.
" (Rural)	E.	J. Dewhirst.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West.	J. S. Pickering.
Cheriton	H.	F. Feather.
Chesham	H.	P. C. Dormer.
Cheshire (County)	L. & C.	H. F. Bull.
Cheshunt	H.	R. H. Jeffes.
Chester	L. & C.	I. M. Jones.
Chesterfield	M.	V. Smith.
" (Rural)	M.	E. Lines.
Chesterton	E.	J. D. Bland.
" (Rural)	E.	J. Dunn.
Chichester	H.	F. J. Lobley.
Chippenham	West.	A. E. Adams.
Chiswick	H.	J. Barclay.
Chorley	L. & C.	W. Leigh.
Christchurch	H.	E. I. Legg.
Church	L. & C.	W. E. Wood.
Clayton-le-Moors	L. & C.	A. Dodgeon.
Cleckheaton	Y.	C. Lund.
Cleethorpes	E.	E. Rushton.
Coalville	M.	L. L. Baldwin.
Coatbridge, N.B.	S.	C. Young.
Cockermouth	N.	F. O. C. Nash.

TOWN.	DISTRICT.	NAME.
Cockermouth (Rural)	N.	J. B. Wilson.
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.
Colombo, Ceylon	Ind.	F. A. Cooper.
" "	Ind.	R. Skelton.
Colwyn Bay	W.N.	W. Jones.
Congleton	L. & C.	R. Burslam.
Consett	N.	W. S. Shell.
Conway (Rural)	W.N.	T. B. Farrington.
Cork	I.	J. F. Delany.
Cork (County), West	I.	R. W. Longfield.
" " South	I.	S. A. Kirkby.
Cottingham	Y.	J. H. Hanson.
Cowes, Isle of Wight	H.	J. W. Webster.
Cowpen	N.	R. Grieves.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Croydon	H.	G. F. Carter.
" (Highways)	H.	E. F. Morgan.
" (Rural)	H.	R. M. Chart.
" (Rural) (Highways)	H.	J. S. Killick.
Cumberland (County)	N.	G. J. Bell.
Cupar (Fife) (County)	S.	T. Aitken.
Dartford	H.	T. E. Tiffen.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Delhi	Ind.	T. Salkield.
Denton	L. & C.	G. H. Newton.
Derby	M.	J. Ward.
" (County)	M.	J. W. Horton.
Desborough	M.	D. J. Diver.
Devon (County)	West.	S. Ingram.
Dewsbury	Y.	H Dearden.
Doncaster (Rural) (Highways)	Y.	W. Crabtree.
Dorchester	West.	G. J. Hunt.
Dorking	H.	G. S. Mathews.
" (Rural)	H.	W. Rapley.
Douglas, Isle of Man	L. & C.	F. Cottle.
Down (County)	I.	J. Heron.
Driffield (Rural)	Y.	T. C. Beaumont.
Droylsden	L. & C.	C. Hall.
Dublin	I.	S. Harty.
" (County)	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire (County)	S.	A. Wilson.
Dundee	S.	J. Thomson.
Dunfermline (County)	S.	D. MacKenzie.
Dunoon, N.B.	S.	J. Andrew.
Dunstable	M.	J. Stewart.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Ham	H.	A. H. Campbell.
East Molesey	H.	J. Stevenson.

TOWN.	DISTRICT.	NAME.
East Retford (Rural)	M.	T. Henry.
East Stow (Rural)	E.	G. F. P. Harrison.
Eastbourne	H.	A. E. Prescott.
Ebbw Vale	West.	T. J. Thomas.
Eccles	L. & C.	T. S. Picton.
Edinburgh, N.B.	S.	J. Massie.
Elgin, N.B.	S.	A. A. Turriff.
Enfield	H.	R. Collins.
Enniskillen (County)	I.	J. P. Burkitt.
Epsom	H.	E. R. Capon.
Erdington	M.	H. H. Humphries.
Erith	H.	H. Hind.
Eston	Y.	C. McDermid.
Eton (Rural)	H.	R. Hallam.
„ „ (Highways)	H.	A. Gladwell.
Evesham	M.	R. C. Mawson.
Exeter	West.	T. Moulding.
Exmouth	West.	S. Hutton.
Falmouth	West.	W. H. Tressider.
Falkirk, N.B.	S.	D. Ronald.
Fareham	H.	W Butler.
Farnborough	H.	J. E. Hargreaves.
Farnham	H.	R. W. Cass.
Faversham	H.	S. P. Andrews.
Fenny Stratford	H.	J. Chadwick.
Finchley	H.	C. J. Jenkin.
Finsbury	Met.	P. G. Killick.
Flintshire (County)	W.N.	S. Evans.
Folkestone	H.	A. E. Nichols.
Foot's Cray	H.	W. A. Farnham.
Friern Barnet	H.	E. J. Reynolds.
Frimley	H.	T. C. Jones.
Frinton-on-Sea	E.	E. M. Bate.
Frome	West.	F. W. Jones.
Gainsborough	E.	S. W. Parker.
Galway (County), East	I.	J. Smith.
Gateshead	N.	N. P. Pattinson.
Germiston, South Africa	Af.	J. Riley.
Gillingham	H.	J. L. Redfern.
Glamorgan (County)	W.S.	G. A. Phillips.
Glasgow, N.B.	S.	A. B. McDonald.
Glasgow, N B.	S.	T. Nisbet.
Glastonbury	West.	G. Alves.
Gloucester	West.	R. Read.
„ (County)	West.	R. Phillips.
Glyncorrwg	W S.	W. P. Jones.
Godalming	H.	J. H. Norris.
Godstone (Rural)	H.	J. George-Powell.
Goole	Y.	E. H. Barber.
Gorton	L. & C.	J. W. Wiles.
Gosforth	N.	G. Nelson
Gosport and Alverstoke	H.	H. Frost.
Govan, N.B.	S.	F. G. Holmes.
Gravesend	H.	F. T. Grant.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	H. G. Whyatt.

TOWN.	DISTRICT.	NAME.
Great Yarmouth	E.	J. W. Cockrill.
Greenock, N.B.	S.	A. J. Turnbull.
Grey County, New Zealand	A.	J. Higgins.
Greymouth, New Zealand	A.	E. I. Lord.
Guernsey	H.	T. J. Guilbert.
Guildford	H.	C. G. Mason.
„ (Rural)	H.	J. Anstee.
Hackney	Met.	N. Scorgie.
Hadham and Stansted	H.	E. T. Watts.
Halifax (Rural)	Y.	F. Gordon.
Hamilton, N.B.	S.	W. H. Purdie.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	O. E. Winter.
Hampton-on-Thames	H.	S. H. Chambers.
Hampton Wick	H.	J. N. Horsfield.
Handsworth	M.	H. Richardson.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrow	H.	J. P. Bennetts.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	J. S. Green.
Hastings	H.	P. H. Palmer.
Haverhill	E.	F. W. Knewstubb.
Hawick, N.B.	S.	Chas. Brown.
Hayes	H.	C. C. Gray.
Heckmondwike	Y.	J. Saville.
Helensburgh, N.B.	S.	J. R. Wilson.
Hemel Hempstead	M.	W. R. Locke.
Hendon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed (Rural)	W.S.	J. P. Jones.
Hereford	M.	J. Parker.
„ (County)	M.	A. Dryland.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Heysham	L. & C.	H. Miller.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Hinckley	M.	E. H. Crump.
Hitchin	H.	A. T. Blood.
Hobson County, N.Z.	A.	H. Hammond.
Holborn	Met.	E. F. Spurrell.
Holyhead	W.N.	A. Asquith.
Hornsea	Y.	W. E. Warburton.
Hornsey	H.	E. J. Lovegrove.
Horsforth	Y.	R. R. Jones.
Horsham	H.	R. Renwick.
Hove	H.	H. H. Scott.
Howrah, Bengal	Ind.	A. Hale.
Hoylake and West Kirby	L. & C.	R. W. Fraser.
Hoyland Nether	Y.	H. G. Keywood.
Huddersfield	Y.	K. F. Campbell.
„ (Gas)	Y.	E. A. Harman.
Hull	Y.	A. E. White.
Huntingdon (County)	M.	H. J. G. Leete.
Hutt County, N.Z.	A.	A. W. Newton.
Hyde	L. & C.	J. Mitchell.
Hythe	H.	Chris. Jones.

TOWN.	DISTRICT.	NAME.
Ilford	E.	H. Shaw.
Ilfracombe	West.	O. M. Prouse.
Inglewood, N.Z.	A.	L. G. P. Spencer.
Inverness	S.	T. H. Scott.
Ipswich	E.	E. Buckham.
Irlam	L. & C.	G. H. Kay.
Ipswich, Queensland	A.	T. Kirk.
Isle of Ely, North (County)	E.	H. F. Simpson.
Islington	Met.	J. P. Barber.
Itchen	H.	T. A. Collingwood.
Johannesburg	Af.	A. P. Lambert.
Kearsley	L. & C.	H. Nuttall.
Kenilworth	M.	S. Douglas.
Kensington	Met.	A. R. Finch.
Kent (County)	H.	H. P. Maybury.
Kesteven (County)	E.	W. B. Purser.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West.	H. M. Bennett.
Kidderminster (Rural)	M.	A. Comber.
Kilkenny (ounty)	I.	A. M. Burden.
Kilmarnock, N.B.	S.	R. Blackwood.
King's Lynn	E.	J. H. Webb.
King's Norton	M.	A. W. Cross.
Kingston (Highways)	H.	A. J. Henderson.
Kingston, Jamaica	A.	C. V. Abrahams.
Kingston-on-Thames	H.	R. H. Clucas.
King Williamstown, S.A.	Af.	J. Maden.
Kirkcaldy	S.	J. L. Lumsden.
Kirkcudbrightshire (County)	S.	J. D. Smith.
Kirriemuir, N.B.	S.	J. S. Bruce.
Kroonstad, O.R.C.	Af.	F. Brown.
Krugersdorp, Transvaal	Af.	R. A. Webster.
Lagos	Af.	I. T. Hawkins.
Lambeth	Met.	H. C. J. Edwards.
Lanark (County)	S.	W. L. Douglass.
Lancashire (County)	L. & C.	W. H. Schofield.
Lancaster	L. & C.	J. C. Mount.
Lanchester (Rural) (Highways)	N.	W. Cumming.
Leatherhead	H.	J. E. Smales.
Leeds	Y.	W. T. Lancashire.
Leeds (Sewerage)	Y.	G. A. Hart.
Leek	M.	W. E. Beacham.
Leicester	M.	E. G. Mawbey.
„ (County)	M.	S. P. Pick.
Leigh	L. & C.	T. Hunter.
„ (Rural)	L. & C.	T. W. B. Gent.
Leigh-on-Sea	E.	J. W. Liversedge.
Leith, N.B.	S.	J. R. Findlay.
Leitrim (County)	I.	E. O'N. Clarke.
Levenshulme	L. & C.	J. Jephson.
Lewisham	Met.	E. Van Putten.
Leyland	L. & C.	W. H. Wilkinson.

TOWN.	DISTRICT.	NAME.
Leyton	H.	W. Dawson.
Lichfield	M.	E. Brooke.
Limehurst (Rural)	L. & C.	H. H. Turner.
Limerick (County)	I.	J. Horan.
Lincoln	E.	R. A. MacBrair.
„ (County)	E.	J. Thropp.
Linlithgow (Highways)	S.	A. Forbes.
Litherland	L. & C.	A. H. Carter.
Littleborough	L. & C.	G. H. Wild.
Littlehampton	H.	H. Howard.
Little Woolton	L. & C.	R. Simmons.
Liverpool	L. & C.	J. A. Brodie.
Llandaff (Rural)	W.S.	J. Holden.
Llandudno	W.N.	E. P. Stephenson.
Llanelly	W.S.	G. Watkeys.
Llantrissant (Rural)	W.S.	G. S. Morgan.
Loftus	Y.	T. H. Tarbit.
London	Met.	F. Sumner.
„ (County)	Met.	M. Fitzmaurice.
Londonderry	I.	W. J. Robinson.
Longford (County)	I.	J. W. Gunnis.
Longton	M.	J. W. Wardle.
Loughborough	M.	A. H. Walker.
Louth (County)	I.	P. J. Lynam.
Lower Bebington	L. & C.	H. W. Corrie.
Lower Hutt, N.Z.	A.	T. Ward.
Lowestoft	E.	G. H. Hamby.
Lucknow (United Provinces)	Ind.	H. Lane Brown.
Ludlow	West.	J. A. Spreckley.
Lurgan	I.	H. Shillington.
Luton	M.	S. F. L. Fox.
Lymington	H.	F. H. Parr.
Lytham	L. & C.	A. J. Price.
Macclesfield (Rural)	L. & C.	J. Thorpe.
Maesteg	W.S.	J. Humphreys.
Maidstone	H.	T. F. Bunting.
Maldon	E.	T. R. Swales.
Malvern	M.	W. O. Thorp.
Manchester	L. & C.	T. De C. Meade.
Mansfield	M.	R. F. Vallance.
Mansfield Woodhouse	M.	F. P. Cook.
Margam, Port Talbot	W.S.	J. Cox.
Margate	H.	E. A. Borg.
Market Harborough	M.	H. G. Coales.
Marylebone	Met.	J. A. P. Waddington
Matlock	M.	J. Diggle.
Matlock Bath	M.	W. Jaffrey.
Maxwelltown, N.B.	S.	J. McL. Bowie.
Melbourne	A.	W. Thwaites.
Melford (Rural)	E.	W. Carver.
Melton Mowbray	M.	E. Jeeves.
Merthyr Tydvil	W.S.	T. F Harvey.
Methley	Y.	T. W. Nichols.
Mexborough	Y.	G. F. Carter.
Middlesbrough	Y.	F. Baker.
Middlesex (County)	H.	H. T. Wakelam.
Middleton	L. & C.	W. Welburn.

TOWN.	DISTRICT.	NAME.
MIDHURST (Rural)	H.	A. G. Gibbs.
MIDSOMER NORTON	West.	W. F. Bird.
MILTON-NEXT-SITTINGBOURNE	H.	W. R. Warlow.
MINEHEAD	West.	J. H. Wooton-Smith.
MONMOUTHSHIRE (County)	West.	W. Tanner.
MONTGOMERY	W.N.	W. P. Hole.
MONTROSE, N.B.	S.	S. L. Christie.
MORLEY	Y.	W. E. Putman.
MORPETH (Rural) (Highways)	N.	J. M. MacGregor.
MUSSELBURGH, N.B.	S.	G. Landale.
NANTYGLO AND BLAINA	West.	W. J. Davies.
NEATH	W.S.	D. M. Jenkins.
„ (Rural)	W.S.	W. E. C. Thomas.
NELSON	L. & C.	B. Ball.
NESTON	L. & C.	C. E. Senior.
NEW MALDEN	H.	T. B Simmonds.
NEW SWINDON	H.	H. J. Hamp.
NEWARK	M.	G. Sheppard.
„ (Rural)	M.	R. Oakden.
NEWBURN-ON-TYNE	N.	T. Gregory.
NEWBURY	H.	S. J. L. Vincent.
NEWHAVEN	H.	F. J. Rayner.
NEWMARKET	E.	J. W. Metcalf.
NEWPORT, MON.	West.	R. H. Haynes.
NEWTON ABBOT	West.	L. Stevens.
NEWTOWN ST. BOSWELLS, N.B.	S.	G. Monteath.
NORTHAMPTON	M.	A. Fidler.
NORTHUMBERLAND (County)	N.	J. A. Bean.
NORTHWICH	L. & C.	J. Brooke.
NORWICH	E.	A. E. Collins.
NOTTINGHAM	M.	A. Brown.
„ (County)	M.	E. P. Hooley.
NUNEATON	M.	F. C. Cook.
OAKHAM (Rural)	E.	C. W. Maudsley.
OAKWORTH	Y.	J. Spencer.
OGMORE AND GARRW	W.S.	H. D. Williams.
OLDBURY	M.	T. H. Shipton.
OSWESTRY	M.	G. W. Lacey.
OTLEY	Y.	J. E. Sharp.
OXFORD	H.	W. H. White.
OXFORDSHIRE (County)	H.	S. Stallard.
PADDINGTON	Met.	E. B. Newton.
PADIHAM	L. & C.	J. Gregson.
PAIGNTON	West.	C. O. Baines.
PAISLEY, N.B.	S.	J. Lee.
PARTICK, N.B.	S.	J. Bryce.
PEEBLES (County)	S.	R. S. Anderson.
PEMBERTON	L. & C.	G. Heaton.
PENANG, S. S.	A.	L. M. Bell.
PENARTH	W.S.	E. I. Evans.
PENGE	H.	H. W. Longdin.
PENRITH	N.	J. J. Knewstubb.

TOWN.	DISTRICT.	NAME.
Perth, N.B.	S.	R. McKillop.
Perth, West Australia	A.	H. T. Haynes.
Peterborough	M.	J. W. Walshaw.
Plymouth	West.	J. Paton.
Pollokshaws, N.B.	S.	D. Burns.
Pontardawe (Rural)	W.S.	J. Morgan.
Pontefract	Y.	J. E. Pickard.
Pontypridd	W.S.	P. R. A. Willoughby
Poole	W.	S. J. Newman.
Port Elizabeth, South Africa	Af.	A. S. Butterworth.
Port Glasgow, N.B.	S.	J. Murray.
Portishead	West.	F. H. Smith.
Portland	West.	R. S. Henshaw.
Portslade-by-Sea	H.	A. T. Allen.
Portsmouth	H.	P. Murch.
Prahran, Victoria	A.	W. Calder.
Queen's County	I.	H. V. White.
Queenstown, South Africa	Af.	W. A. Palliser.
Ramsbottom	L. & C.	T. H. Bell.
Ramsgate	H.	T. G. Taylor.
Rawmarsh	Y.	J. Bourne.
Rawtenstall	L. & C.	J. Johnston.
Redcar	Y.	J. Howcroft.
Redditch	M.	A. J. Dickinson.
Redruth	West.	T. W. Joyce.
Reigate	H.	F. T. Clayton.
Renfrewshire (County), N.B.	S.	J. Murray.
Retford	M.	J. D. Kennedy.
Rhondda	W.S.	W. J. Jones.
Rhymney	West.	W. L. Marks.
Richmond, Surrey	H.	J. H. Brierley.
Richmond, Yorks	Y.	T. H. Hailstone.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Rochford (Rural)	H.	H. T. Sidwell.
Rotherham	Y.	G. Jennings.
Rowley Regis	M.	W. H. Brettell.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
,, (Rural)	L. & C.	W. Diggle.
Rushden	M.	W. B. Madin.
Rutherglen, N.B.	S.	S. McBride.
Rutland (County)	E.	J. Richardson.
Ryton-on-Tyne	N.	J. P. Dalton.
Saffron Walden	E.	A. H. Forbes.
St. Albans	H.	G. Ford.
St. Andrews, N.B.	S.	W. Watson.
St. Pancras	Met.	W. N. Blair.
Sale	L. & C.	W. Holt.
Salford	L. & C.	J. Corbett.
Saltburn-by-the-Sea	Y.	G. S. L. Bains.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

A.	*signifies*	ABROAD.	Met.	*signifies*	METROPOLITAN DISTRICT.
Af.	„	AFRICAN DISTRICT.	M.	„	MIDLAND DISTRICT.
E.	„	EASTERN DISTRICT.	N.	„	NORTHERN DISTRICT.
H.	„	HOME DISTRICT.	S.	„	SCOTTISH DISTRICT.
Ind.	„	INDIAN DISTRICT.	W.N.	„	WELSH DISTRICT (North).
I.	„	IRISH DISTRICT.	W.S.	„	„ „ (South).
L. & C.	„	LANCASHIRE & CHESHIRE DISTRICT.	West.	„	WESTERN DISTRICT.
			Y.	„	YORKSHIRE DISTRICT.

TOWN.	DISTRICT.	NAME.
ABERCARN	West.	J. Williams.
ABERDEEN	S.	W. Dyack.
ABERGAVENNY	West.	J. Haigh.
ABINGDON	H.	G. Winship.
ABRAM	L. & C.	G. Heaton.
ACCRINGTON	L. & C.	W. J. Newton.
ACTON	H.	D. J. Ebbetts.
ALDERSHOT	H.	F. C. Uren.
ALNWICK	N.	G. Wilson.
ANDOVER	H.	R. W. Knapp.
ANNFIELD PLAIN	N.	T. J. Trowsdale.
ANTRIM (County)	I.	J. H. Brett.
ARBROATH, N.B.	S.	P. C. Smith.
ARGYLLSHIRE (County)	S.	M. B. McBeth.
ARMAGH	I.	J. C. Boyle.
„ (County)	I.	R. H. Dorman.
ASHBOURNE	M.	W. Stringfellow.
ASHBY-DE-LA-ZOUCH	M.	S. Turner.
ASHFORD	H.	W. Terrill.
„ (Rural)	H.	A. Sims.
ASHTON-UNDER-LYNE	L. & C.	J. T. Earnshaw.
ASHTON-ON-MERSEY	L. & C.	F. Hutton.
ASTON MANOR	M.	G. H. Jack.
ATHERSTONE (Rural)	M.	H. J. Coleby.
ATHERTON	L. & C.	W. Clough.
„	L. & C.	F. H. Grimshaw.
ATHLONE (County)	I.	C. J. Mulvany.
AUCKLAND, NEW ZEALAND	A.	W. E. Bush.
AUDLEY	M.	T. Bibbey.
AYR	S.	J. Young.
AYRSHIRE (County)	S.	A. Stevenson.
BALBY WITH HEXTHORPE	Y	G. Gledhill.
BALLYMENA	I.	H. O'Hara.
BANBURY	H.	N. H. Dawson.
BANGOR, Co. DOWN	I.	E. L. Woods.
BARKING	H.	C. F. Dawson.
BARNES	H.	G. B. Tomes.
BARNSTAPLE	West.	E. Y. Saunders.

TOWN.	DISTRICT.	NAME.
Barrow-in-Furness	L. & C.	J. W. Smith.
Barry	W.S.	J. C. Pardoe.
Barton-upon-Irwell (Rural) ..	L. & C.	C. C. Hooley.
Basford (Rural)	M.	S. Maylan.
„ „ (Highways) ..	M.	G. W. Hawley.
Basingstoke	H.	F. R. Phipps.
Battersea	Met.	T. W. A. Hayward.
Beccles	E.	T. O. Cudbird.
Beckenham	H.	J. A. Angell.
Bedford	H.	N. Greenshields.
Bedford (County)	H.	W. H. Leete.
Belfast	I.	H. A. Cutler.
Belper	M.	T. Fenn.
„ (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Berkshire (County)	H.	J. F. Hawkins.
Bermondsey	Met.	R. J. Angel.
Berwick-on-Tweed	S.	R. Dickinson.
Berwickshire (County), N.B. ..	S.	T. R. Atkinson.
Bethnal Green	Met.	E. E. Finch.
Beverley	Y.	J. G. Smith.
„ (Rural)	Y.	E. Picker.
Bexhill	H.	G. Ball.
Bexley	H.	W. T. Howse.
Biddulph	M.	S. Gibson.
Biggleswade	H.	T. Cockrill.
„ (Rural)	H.	J. O. Jones.
Bilston	M.	J. P. Wakeford.
Bingley	Y.	H. Bottomley.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	H. E. Stilgoe.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
Blackburn	L. & C.	W. Stubbs.
Blackpool	L. & C.	J. S. Brodie.
Blackwell (Rural)	M.	H. Silcock.
Bloemfontein, South Africa ..	Af.	H. F. Peet.
Blyth and Cuckney (Rural) ..	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bombay	Ind.	J Hall.
Bo'ness, N.B.	S.	J. P. Lawrie.
Bootle	L. & C.	B. J. Wolfenden.
Boston, Lincs.	E.	G. E. Clarke.
Bourne (Rural)	E.	A. J. Metcalfe.
Bournemouth	H.	F. W. Lacey.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West.	A. S. Wootton.
Braintree	E.	H. H. Naukivell.
Brecon	W.	H. Ll. Griffiths.
Brentford	H.	N. Parr.
Bridgend	W.S.	M. Williams.
Bridgwater	West.	F. Parr.
Bridgwater (Rural)	West.	W. A. Collins.
Bridlington	Y.	E. R. Matthews.
„ (Rural)	Y.	S. Dyer.
Brierfield	L. & C.	B. Halstead.
Brierley Hill	M.	J. L. Harpur.
Brighouse	Y.	S. S. Haywood.
Brisbane, Queensland	A.	J. Kemp.

TOWN.	DISTRICT.	NAME.
Wandsworth (Eastern)	Met.	H. J. Marten.
" (Western)	Met.	P. Dodd.
Wanstead	H.	J. T. Bressey.
Wantage	H.	W. Hanson.
Ware	H.	H. F. Hill.
Warminster	West.	C. H. Lawton.
Warwickshire (County)	M.	J. Willmot.
Waterford	I.	M. J. Fleming.
" (County)	I.	W. E. L. Duffin.
Waterloo	L. & C.	F. S. Yates.
Watford	H.	D. Waterhouse.
Wath-upon-Dearne	Y.	H. C. Poole.
Wealdstone	H.	H. Walker.
Wellingborough	M.	E. Y. Harrison.
Wembley	H.	C. R. W. Chapman.
West Bromwich	M.	A. D. Greatorex.
West Hartlepool	N.	N. F. Dennis.
West Malling (Rural)	H.	J. Marshall.
Westminster	Met.	J. W. Bradley.
Weston-super-Mare	West.	H. Nettleton.
Weymouth and Melcombe Regis	West.	W. B. Morgan.
Whitchurch	M.	M. Sowden.
Whitehaven	N.	E. E. Stiven.
Wicklow	I.	J. Pansing.
Widnes	L. & C.	J. S. Sinclair.
Willenhall	M.	T. E. Fellows.
Willesden	H.	O. C. Robson.
Willington Quay	N.	J. F. Davidson.
Wilmslow	L. & C.	A. S. Cartwright.
Wimbledon	H.	C. H. Cooper.
Winchester	H.	W. V. Anderson.
" (Rural)	H.	G. E. Carter.
Windermere	L. & C.	C. E. Hines.
Windsor	H.	E. A. Stickland.
Winton	H.	J. H. Scott.
Wokingham	M.	C. W. Marks.
Wolverhampton	M.	G. Green.
Wombwell	Y.	J. W. Harrison.
Wood Green	H.	C. J. Gunyon.
Woodford	E.	W. Farrington.
Woolwich	Met.	J. R. Dixon.
Worcester	M.	T. Caink.
" (County)	M.	J. H. Garrett.
Worksop	M.	F. S. Whittell.
Worthing	H.	F. Roberts.
Wortley (Rural)	Y.	G. E. Beaumont.
Wrexham (Rural)	W.N.	J. P. Evans.
York	Y.	A. Creer.
Yorkshire, East Riding	Y.	A. Beaumont.
" North Riding	Y.	W. G. Bryning.

ASSOCIATES.

* *Those Associates against whose names a star is placed have obtained the certificate of the Association.*

G *signifies elected as Graduate.*

TA *transferred to Associate Class.*

Date of Election and Transfer.		
1906 June 28	*Ash, H. J.	Chief Engineering Assistant, Council Offices, Nuneaton.
1901 Oct. 19	Ashbee, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1906 May 26	*Ballard, W. E.	Assistant Engineer, Council Offices, King's Heath, near Birmingham.
1904 Sept. 17	Bell, C. D., B.Sc. (*Vict.*)	Borough Engineer's Office, Barrow-in-Furness.
1906 Dec. 15	Belsher, B. J.	Assistant Borough Engineer, Stepney.
G1897 July 31 TA1901 Oct. 19	*Bentley, J. H., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Oldham.
G1904 May 28 TA1905 June 22	*Berridge, H. M. K., Assoc. M. Inst. C.E.	Assistant Surveyor, Council Offices, Long Eaton.
G1898 June 30 TA1901 Oct. 19	*Best, H. Storr	Assistant Engineer, Council Offices, Beckenham, S.E.
G1893 June 24 TA1902 Nov. 8	*Birch, J.	Deputy Surveyor, Public Offices, East Ham.
1903 Jan. 17	*Booth, E. W., A. M. Inst. C.E.	Engineering Assistant, Town Hall, Croydon.
G1899 June 10 TA1905 Jan. 28	*Bradshaw, A. S.	Deputy Borough Engineer, Bedford.
G1898 June 30 TA1903 June 25	*Briscoe, J. T.	Deputy Engineer, Council Offices, Enfield.
1903 July 25	*Bromly, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
1902 Jan. 25	Brookes, A. E.	Assistant County Surveyor, Worcester C.C. Breedon Cross, King's Norton, Birmingham.
1902 Jan. 25	Brown, H. A.	Assistant Borough Surveyor, Town Hall, Fulham, S.W.
1904 May 28	*Burton, W. E. H., Assoc. M. Inst. C.E.	Chief Engineering Assistant, County Architect's Office, Wakefield.
1904 Sept. 1	Carson, W. H., Assoc. M. Inst. C.E.	City Engineer's Office, Glasgow, N.B.
1904 May 28	Carter, E. W. A.	Assistant City Surveyor, Guildhall, Gloucester.
G1890 Sept. 13 TA1902 Sept. 6	*Catchpole, H.	Deputy Engineer, Council Offices, Finchley.
G1895 May 25 TA1902 May 10	*Clark, A. H. F.	District Engineer, P.W.D., Ceylon.

Date of Election and Transfer.		
G1894 July 7 TA1904 Sept. 17	*CLAYPOOLE, A. H., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1898 Dec. 17 TA1902 Mar. 22	*CLEWS, C. A.	Engineering Assistant, Borough Surveyor's Office, Derby.
G1899 June 29 TA1902 Jan. 25	*COLLINGE, T. P., A.M. Inst. C.E.	Deputy City Engineer, Town Hall, Carlisle.
1905 May 27	COLLINS, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
G1897 Feb. 13 TA1901 Oct. 19	*COLLIS-ADAMSON, A. C. ..	Assistant Borough Engineer, Hornsey, N.
1904 Oct. 11	CONNOR, C.	c/o W. Kennedy, Ltd., 25 Victoria Street, Westminster.
1903 May 16	COOKE, J. E.	Assistant Borough Engineer, Town Hall, Islington.
G1900 May 19 TA1901 Oct. 19	*COOMBS, C. A.	Engineering Assistant, Town Hall, Burton-on-Trent.
G1899 Oct. 21 TA1902 Nov. 8	*COWAN, G.	District Surveyor, Town Hall, Portsmouth.
G1901 Aug. 24 TA1901 Oct. 19	*COX, A. L.	City Surveyor's Office, Manchester.
1905 Mar. 4	*COX, C. L.	Assistant Engineer, Municipal Offices, Colombo.
1902 Jan. 25	CROOK, W. E.	Chief Engineering Assistant, Middlesex C.C. Guildhall, Westminster.
1906 Nov. 3	CROSS, W. G.	Assistant Borough Surveyor, Tunbridge Wells.
1901 Oct. 19	*CROXFORD, C. H.	Chief Engineering Assistant, Town Hall, Wood Green, N.
G1903 Dec. 12 TA1905 May 27	*DEBNEY, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
1904 Aug. 19	DE KRETSER, H. K.	District Engineer, P. W. D., Colombo, Ceylon.
G1891 Sept. 12 TA1902 Sept. 6	*DOLAMORE, F. P.	Deputy Borough Engineer, Bournemouth.
1904 Aug. 12	DONALD, R. B., A.M.Inst.C.E.	Resident Engineer's Office, Sewage Disposal Works, Huddersfield.
1906 June 28	*DRESDEN, W. J.	Chief Engineering Assistant, Town Hall, Battersea.
G1899 June 29 TA1905 June 22	*DYER, B. H.	Assistant Borough Engineer, Southend-on-Sea.
G1898 Dec. 17 TA1901 Dec. 7	*ELLISON, D., A.M.Inst.C.E.	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25	*ENDSOR, H. A.	Surveyor, Rural District Council, Keynsham, Bristol.
1904 Aug. 27	FORBES, W.	Burgh Engineer's Office, Edinburgh, N.B.
G1899 Oct. 21 TA1903 July 25	*FOSTER, H. H.	Assistant Surveyor, Borough Surveyor's Office, Wandsworth. 215 High Rd., Balham.

Date of Election and Transfer.		
G1901 June 8 / TA1901 Oct. 19	*FOWLDS, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Keighley.
G1901 May 11 / TA1902 Jan. 25	*GAIR, J.	Assistant Borough Surveyor, Town Hall, Hammersmith, W.
P1903 Mar. 21	GALBRAITH, A. R., A.M. Inst. C.E.I.	District Surveyor, Town Hall, Portsmouth.
1905 June 22	*GAMMAGE, E. J.	Borough Surveyor's Office, Dudley.
G1898 Jan. 15 / TA1903 Jan. 17	*GODFREY, C. H., A.M. Inst. C.E.	Assistant Engineer, Municipal Offices, Shanghai.
1905 June 22	*GOODE, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 / TA1902 May 10	*GOODFELLOW, H.	Chief Engineering Assistant, Town Hall, Southport.
G1894 Jan. 13 / TA1902 July 10	*GORDON, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen, N.B.
1903 July 25	GRAY, A. B.	Engineering Assistant, Council House, Birmingham.
G1893 Jan. 14 / TA1901 Oct. 19	*GREENWOOD, J. P., A.M. Inst. C.E.	Deputy Borough Surveyor, Town Hall, Burnley.
1904 Aug. 9	GREIG, J. M. M.	7 Hartington Place, Carlisle.
1902 Mar. 22	HADFIELD, W. J.	Deputy City Surveyor, Town Hall, Sheffield.
G1897 June 19 / TA1901 Oct. 19	*HAIGH, W. H., A.M. Inst. C.E.	Chief Engineering Assistant, Town Hall, Cardiff.
1903 June 6	HARDING, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1899 Oct. 21 / TA1902 May 10	*HARPER, A.	Deputy Borough Surveyor Town Hall, St. Helen's, Lancs.
1906 Mar. 3	*HASKINS, W. J.	Assist. Superintendant, P.W.D., Singapore, S.S.
1903 June 6	HEAP, H., A. M. Inst. C.E. ..	16 Manor Avenue, Grimsby.
G1903 Jan. 17 / TA1905 Apr. 29	*HEATH, J. R.	Assistant Borough Surveyor, Burslem.
1904 Aug. 26	HENDERSON, R. T...	City Engineer's Office, City Chambers, Glasgow, N.B.
G1905 Dec. 9 / TA1906 Dec. 15	*HEWITT, F.	Borough Road Surveyor, Southport.
G1900 Mar. 10 / TA1902 May 10	*HINCHSLIFF, E. R...	Deputy Surveyor, Council Offices, Barry.
1905 Jan. 28	HIPWOOD, J. W., A. M. Inst. C.E.	Chief Assistant, Borough Eng. Office, Southend-on-Sea.
G1900 Aug. 25 / TA1902 Mar. 22	*HOLLOWAY, W. C.	Chief Engineering Assistant, Council Offices, Kettering.
G1897 July 31 / TA1902 Nov. 8	*JENKINS, R. J.	Chief Assistant, Town Hall, Portsmouth.
G1900 June 16 / TA1901 Oct. 19	*JERRAM, G., A.M. Inst. C.E.	Assistant Surveyor, Town Hall, Walthamstow, N.E.
G1897 June 19 / TA1902 Jan. 25	*JOHNSTON, R. W.	Deputy Borough Engineer Town Hall, Birkenhead.

Date of Election and Transfer.		
G1901 June 8 / TA1904 Mar. 26	*JONES, H. O.	Assistant Borough Engineer, Folkestone.
1902 May 10	KER, A. M., B. Sc. (*Vict.*), A.M. Inst. C.E.	Assistant Borough Engineer, Town Hall, Warrington.
G1896 June 25 / TA1906 Dec. 15	*KIESER, W. H. G., Assoc. M. Inst. C.E.	District Surveyor, Bristol.
1906 Mar. 3	*KINNEAR, C. F. A.	City Chambers, Edinburgh.
1904 Feb. 27	KIRBY, H. C.	Town Engineer's Department, Pretoria, South Africa.
1901 Dec. 7	LASHMORE, E. W., Assoc. M. Inst. C.E.	District Surveyor, Alma Vale Road, Clifton, Bristol.
G1903 June 25 / TA1906 Dec. 15	*LEES, H. B.	District Eng., Jaffna, Ceylon.
G1901 May 11 / TA1901 Oct. 19	*LISMER, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
1904 Sept. 6	McINNES, D.	City Engineer's Office, Glasgow, N.B.
1902 Nov. 8	McKENZIE, L. S., A.M.Inst.C.E.	District Surveyor, 63 Queen Square, Bristol.
1903 Mar. 21	MANNING, W. R., A. M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
1904 Aug. 4	MARR, G. E.	District Offices, Hamilton, N.B.
1903 Jan. 17	MARSHALL, L. P., M. Inst. C.E.	Northern Outfall Works, Beckton, E.
G1900 Apr. 21 / TA1901 Dec. 7	*MILLER, G. F.	Chief Assistant, Borough Engineer's Office, Hastings.
G1898 Dec. 17 / TA1901 Oct. 19	*MITCHELL, G.	Tofany Storage Reservoir, Kilco Post Office, Co. Down, Ireland.
1904 Sept. 19	MORRISON, A. W.	Burgh Engineer's Office, Edinburgh, N.B.
G1901 Aug. 24 / TA1902 Nov. 8	*NEAVE, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
1904 Aug. 17	OLIVER, J. R.	Burgh Engineer's Department, Edinburgh, N.B.
G1895 June 27 / TA1902 July 10	*OPENSHAW, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
G1902 Mar. 22 / TA1904 Oct. 29	*PARR, J. E., A.M.Inst.C.E.	Chief Assistant, Engineer's Office, Handsworth, Birmingham.
1904 Sept. 5	PATERSON, J. B.	Deputy Burgh Surveyor, Partick, N.B.
G1900 June 16 / TA1902 Feb. 22	*PERCIVAL, W.	Assistant Borough Surveyor, Court House, Longton, Staffs.
1906 Jan. 20	*PERKINS, G. S.	Assistant Surveyor to the Urban District Council, Teddington.
G1895 Jan. 19 / TA1901 Oct. 19	*PERKINS, J.	Engineering Assistant, Council House, Birmingham.

Date of Election and Transfer.		
G1899 Oct. 21 TA1904 June 25	*Plant, W., A. M. Inst. C.E.	Borough Engineer's Office, Leicester.
1903 Dec. 12	*Race, A...	Chief Assistant, Borough Engineer's Office, Barrow-in-Furness.
1902 Mar. 22	Ransom, W., A. M. Inst. C.E.	Chief Assistant Surveyor, Worcester. Midhurst, Bath Road, Worcester.
1904 Aug. 31	Reid, M...	Burgh Engineer's Office, Paisley, N.B.
1906 May 26	*Robinson, W. P., B.Sc.(Vict.), Assoc. M. Inst. C.E.	Clarence House, The Peth, Durham.
G1903 June 6 TA1904 Mar. 26	*Roseveare, L., A.M.Inst.C.E.	Council House, Birmingham.
1902 Nov. 8	Rowbottom, J.	Chief Assistant, Borough Surveyor's Office, Ashton-under-Lyne.
1903 June 6	Sadler, F.	Deputy Surveyor, Council Offices, Acton.
G1894 Oct. 20 TA1902 May 10	*Savage, E. B., A.M.Inst. C.E.	Engineering Assistant, Council House, Birmingham.
1902 Nov. 8	*Shackleton, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Hanley.
1905 May 27	Sherren, A. O., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Dover.
G1899 Dec. 16 TA1901 Oct. 19	*Slater, F. J.	Assistant Surveyor, Town Hall, Camberwell, S.E.
1904 May 28	*Smith, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.
1906 Apr. 28	Smith, H. J. T.	Assistant Engineer, Municipal Offices, Calcutta.
1901 Dec. 7	Spurr, F. W.	Chief Assistant, City Engineer's Office, York.
G1895 Jan. 19 TA1901 Oct. 19	*Steele, W. J., A.M. Inst. C.E.	Deputy City Engineer, Bristol.
1904 Aug. 22	Stephen, T. M.	[illegible] Offices, Hamilton, N.B.
G1903 June 25 TA1904 Feb. 27	*Stevens, H. L., A.M. Inst. C.E.	[illegible] Assistant Engineer, Council Offices, Watford.
1904 Apr. 30	[illegible], G. E.	[illegible] Western District, [illegible] Sheffield.
1903 Mar. 21	[illegible]	[illegible] Engineer [illegible] Huddersfield.
1905 Sep. 23	[illegible]	[illegible] Surveyor, [illegible]
G18[illegible] De[illegible] TA19[illegible] J[illegible]	[illegible]	[illegible] Engineer, Walsall.
G1[illegible] TA19[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Date of Election and Transfer.		
1905 Jan. 28	Waldram, R. E.	Assistant Borough Engineer, Town Hall, Woolwich.
G1904 May 28 TA1904 Dec. 3	*Walton, J. S.	Borough Engineer's Office, Torquay.
1905 Sep. 23	Ward, A. W., A.M. Inst. C.E.	Assistant Borough Engineer, Northampton.
1903 July 25	*Watmore, Jas.	Assistant Surveyor, Council Offices, Aldershot.
G1899 June 10 TA1902 Mar. 22	*Weir, J. S., A.M. Inst. C.E.	Chief Assistant, Borough Surveyor's Office, Halifax.
G1902 July 10 TA1905 Jan. 28	*Whitaker, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.
1903 May 16	White, W. H. J., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
G1902 Nov. 8 TA1904 Feb. 27	*Wibberley, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
1902 Mar. 22	Williams, H. B.	Chief Assistant, Borough Engineer's Office, Workington.
1902 July 10	Williams, J.	Assistant Borough Surveyor, Town Hall, Hampstead, N.W.
G1901 Dec. 7 TA1906 Dec. 15	*Williams, J. H.	Deputy Borough Engineer, Todmorden.
1906 Apr. 28	Williams, S. G., Assoc. M. Inst. C.E.	Assistant Engineer, Municipal Offices, Singapore, S.S.
G1898 June 30 TA1901 Dec. 7	*Willis, E., Assoc. M. Inst. C.E.	Chief Engineering Assistant, Council Offices, Willesden, N.W.
1903 June 6	Wilson, A., B.Sc. (*Lond.*), Assoc. M. Inst. C.E.	Depto. Via y Obras, F. C. Sud., Buenos Aires.
G1898 June 30 TA1901 Dec. 7	*Wilson, F., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19	*Yarwood, H.	Assistant Borough Surveyor, Town Hall, Rochdale.
G1901 June 8 TA1902 Feb. 22	*Yelland, T.	Assistant Borough Engineer, Bury.

GRADUATES.

All Graduates hold the Certificate of the Association.

Date of Election.		
1906 April 28	ANDREWS, S. H.	28 Penhurst Road, South Hackney, N.E.
1893 Oct. 2	BALL, J. B., M. Inst. C.E. ..	Engineer's Office, L.D. & E.C. Railway, Chesterfield.
1905 June 22	BARKER, H. W.	Council House, Handsworth, Birmingham.
1890 Mar. 29	BAYLEY, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
1897 July 31	BEARD, E. T., M. Inst. C.E...	4 The Crescent, Scarborough.
1906 June 28	BEAUMONT, R. H...	Greno Lodge, Grenoside, near Sheffield.
1906 Dec. 15	BELL, G. H.	37 Glanmor Crescent, Swansea.
1906 May 26	BENTLEY, W...	468 St. Helens Road, Bolton, Lancs.
1902 Mar. 22	BERRINGTON, E. E. W... ..	28 Victoria Street, Westminster, S.W.
1903 Dec. 12	BIKER, W. J. E.	Municipal Offices, Harrogate.
1900 June 16	BLAKEWAY-PHILLIPS, R. ..	City Engineer's Office, Westminster, S.W.
1901 Aug. 24	BLANCHARD, R.	Town Hall, Leicester.
1889 June 8	BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1905 Jan. 28	BRADLEY, C. G.	Borough Engineer's Office, Leigh.
1896 June 25	BRUCE, W...	Burgh Engineer's Office, Edinburgh.
1889 July 4	BRYANS, J. G., Assoc. M. Inst. C.E.	Sectional Engineer, Palermo Station, F.C.P., Buenos Aires.
1905 May 27	BULL, E. M.	Council Offices, Finchley, N.
1899 June 29	BURGESS, R. W.	Town Hall, Stratford, E.
1903 June 6	BUTLER, H. L.	Surrey House, Surrey Lane, Battersea.
1905 June 22	BUTLER, R.	"Woodthorpe," Prospect Road, Tunbridge Wells.
1904 June 25	BUTT, E. E. W.	Council Offices, Birmingham.
1905 Dec. 9	BUTTERWORTH, G. L.	Surveyor, Isle of Thanet U.D.C., Birchington-on-Sea.
1902 July 10	BUTTON, F. E.	City Surveyor's Office, Manchester.
1906 June 28	CAPLEN, L.	Rusthall, Tunbridge Wells.
1903 Dec. 12	CARTER, S. F. R.	Town Hall, Hounslow.
1897 June 19	CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1906 May 26	CASTLE, J. H...	27 Highbury Park, Highbury, N.
1906 Dec. 15	CATHCART, A. B.	4 St. Mary's Square, Paddington, W.
1904 May 28	CATTLIN, O.	Borough Surveyor's Office, 197 High Holborn, W.C.
1904 Dec. 3	CLARKE, R. E.	Public Offices, Arnold, Notts.
1894 July 7	CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
1903 Dec. 12	COCHRANE, J...	15 Ure Place, Montrose Street, Glasgow.

Date of Election.		
1906 May 26	Conway, F. J. K.	Borough Engineer's Office, Town Hall, Birkenhead.
1906 Dec. 15	Couzens, R. H.	City Engineer's Office, Carlisle.
1904 May 28	Cowlishaw, H. H.	43 Lennard Road, Penge, S.E.
1904 Jan. 23	Cox, C. E.	Windmill Hill, Cradley. Cradley Heath.
1906 Jan. 20	Crabb, H. R.	Council House, Birmingham.
1897 June 19	Creswell, W. T.	11 Victoria Street, S.W.
1906 Sept. 22	Criswell, W.	Contractor's Office, Derwent Valley Waterworks, Bamford, Sheffield.
1892 July 11	Cross, F. W., A.M. Inst. C.E.	"Ingleside," Clifton Road, Sutton Coldfield.
1905 June 22	Cross, W. G.	25 Arundel Road, Tunbridge Wells.
1903 June 6	Cubitt, H. W.	County Hall, Spring Gardens, S.W.
1905 Jan. 28	Darby, A. E.	194 Rishton Lane, Bolton.
1906 Jan. 20	Darby, H.	1 Leighton Road, Ealing.
1901 June 8	Davidge, W. R., Assoc. M. Inst. C.E.	London County Council Offices, 19 Charing Cross Road, W.C.
1902 July 10	Dawkins, F.	Borough Surveyor's Office, Bournemouth.
1902 July 10	Deeley, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
1898 June 30	Dent, J. P.	1 Woodside Terrace, Nelson, Lancashire.
1904 May 28	Draper, J.	Council House, Handsworth, Birmingham.
1903 Oct. 17	Duncan, L. G.	10 Hanover Buildings, Southampton.
1906 May 26	Eayrs, T. W.	"Thornlea," Beeches Road, West Bromwich.
1906 Dec. 15	Edwards, J. H.	9 Talbot Road, Wrexham.
1898 Dec. 17	Essex, E. H., A.M. Inst. C.E.	Town Hall, Leyton, N.E.
1905 May 27	Farrar, W.	Town Hall, Todmorden.
1886 Sept. 11	Fenton, W. C.	14 St. James' Row, Sheffield.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1903 July 25	Ford, J.	Lower House, Branscombe, Axminster.
1903 Feb. 21	Foster, J. W.	Town Hall, Bradford.
1903 June 6	Foster, W. A.	Park View, Manchester Road, Accrington.
1903 June 25	Gettings, S. S., Assoc. M. Inst. C.E.	Resident Engineer's Office, Waterworks, Moreton-in-the-Marsh, Glos.
1899 June 10	Gibson, W. S.	"Everitts," Finchley Lane, N.W.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1905 Jan. 28	Goddard, F. B.	87 Cicada Road, Wandsworth.
1906 Dec. 15	Goldsmith, W. H.	Town Hall, Hull.
1905 June 22	Greenhill, F. G.	"Moorhaven," Headstone Road, Harrow.
1906 May 26	Griffiths, H.	Borough Surveyor's Office, Crewe.
1898 Jan. 15	Grimley, F. C.	Depôt Barracks, Harwich.
1904 Dec. 3	Grove, A.	1 Parkfield Terrace, Stourbridge.
1905 June 22	Gunson, E., A.M. Inst. C.E.	c/o Grindlay & Co., Calcutta.

Date of Election.		
1905 June 22	HADFIELD, J. B.	Borough Surveyor's Office, Bedford.
1904 Jan. 23	HARKNESS, J.	20 Duke Street. Edinburgh.
1901 June 27	HARLOW, W. W. B., Assoc. M. Inst. C.E.	City Engineer's Office, Carlisle.
1901 June 8	HARRIS, K. J. S.	Borough Surveyor, Wisbech.
1906 Mar. 3	HARRISON, J.	53 Ormerod Road, Burnley.
1903 June 25	HARRISON, P. T.	Town Hall, Fulham.
1905 Oct. 28	HASSALL, J.	Resident Engineer's Office, Western Valleys (Mon.) Sewerage Board, Bassaleg, Mon.
1904 May 28	HATTON, J	1 Mill Cliff, Buxton, Derbyshire.
1893 Jan. 14	HELLAWELL, O.	Town Hall, Withington, Manchester.
1906 June 28	HEWES, G. W.	27 Williams Road, Burnley.
1906 Dec. 15	HEWITT, A. C.	"Nutfield," Scarborough Road, Filey. Yorkshire.
1896 June 25	HILLS, O. C.	360 Mare Street, Hackney, N.E.
1900 June 16	HOBSON, E.	117 Oakland Road, Hillsborough, Sheffield.
1906 Mar. 3	HOLDEN, R. B.	Town Hall, Oldham.
1888 July 12	HOUGHTON, J.	King's Heath, Birmingham.
1904 Oct. 29	HOWELL, H. H.	63 Queen Square, Bristol.
1903 Jan. 17	HOWELLS, D. P.	16 Ropewalk, Neath, S. Wales.
1899 June 10	HUTCHINGS, W. A...	Springfield Brewery, Wolverhampton.
1904 Dec. 3	HUTCHINSON, H. F.	2 Queen's Road, Chorley.
1903 Dec. 12	JACQUES, H. S.	Municipal Offices, Cheltenham.
1906 Dec. 15	JENKINSON, F. C.	29B High Street, Rotherham.
1905 Jan. 28	JENNINGS, W...	Borough Engineer's Office, Leyton.
1903 July 25	JONES, T.	53 Princes Street, Southport.
1906 Dec. 15	JONES, T.	Townfield Road, West Kirby.
1895 Oct. 19	JULIAN, J.	Borough Surveyor's Office, Cambridge.
1906 May 26	KING, J. S.	Council Offices, Friern Barnet, New Southgate, N.
1903 June 25	KNIGHT, R. B.	Council Offices, Bromley, Kent.
1903 June 25	KNOWLES, G. P., A.M. Inst. C.E.	39 Victoria Street, S.W.
1905 Dec. 9	LAKE, W. S.	Borough Engineer's Office, Plymouth.
1906 Dec. 15	LEES, R. B.	99 Antrobus Street, Congleton, Cheshire.
1904 June 25	LEWIS, H. M.	Town Hall, Staines.
1904 Dec. 3	LINE, H. W.	L.C.C., 19 Charing Cross Road, S.W.
1906 June 28	LUDFORD, E. W.	Borough Surveyor's Office, Town Hall, Hammersmith.
1905 Sep. 23	LYDDON, A. J.	Borough Engineer's Office, Town Hall, Reading.
1905 May 27	MCARD, A. J.	Edge Hill, Whitehaven.
1900 Dec. 15	MACDONALD, K. G.	13 Charles Street, St. James's, S.W.
1906 Dec. 15	MACKENZIE, W. H.	Les Rosiers, Holdenhurst Road, Bournemouth.

Date of Election.		
1905 May 27	MAITLAND, W. H.	Town Hall, Hoylake, Cheshire.
1903 June 25	MANN, E. E.	Borough Engineer's Office, Southampton.
1904 May 28	MANSFIELD, F.	1 Castle Green Villas, Mill Street, Hereford.
1903 Jan. 17	MARRIAN, H. G., Assoc. M. Inst. C.E.	City Surveyor's Office, Manchester.
1906 April 28	MARSH, F. E.	Municipal Engineer's Office, Singapore, S.S.
1894 Jan. 13	MARTIN, E. B., A.M.Inst.C.E.	City Engineer's Office, Leeds.
1903 Jan. 17	MASTERS, W. H.	Glencairn, Arthur Road, Southampton.
1905 Jan. 28	MATHEW, H. B.	Borough Engineer's Office, Dover.
1906 Dec. 15	MATTHEWS, R. H...	178 High Road, South Tottenham, N.
1905 May 27	MATTHEW, S...	South Villa, Crow Nest Park, Dewsbury.
1900 June 16	MATTINSON, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
1904 May 28	MILLAR, P.	Borough Engineer's Office, Southampton.
1906 May 26	MILNER, J. D., A.M.Inst.C.E.	City Engineer's Office, Hull.
1901 Oct. 19	MILNES, B.	Town Hall, Birkenhead.
1905 May 27	MINORS, E.	City Engineer's Office, Worcester.
1905 June 22	MORGAN, G. L.	11 The Parade, Pontypridd.
1899 June 10	MOSS, P. A.	153 Highbury Hill, Highbury, N.
1902 July 10	NATHANIELSZ, A. H., Assoc. M. Inst. C.E.	P.W.D., Bungalow, Wegambo, Ceylon.
1904 Dec. 3	NEEDHAM, J. E.	Municipal Engineer's Office, Shanghai.
1906 Jan. 20	NEWMAN, W. W.	Borough Offices, Poole.
1906 Jan. 20	NEWSOME, S. H.	City Surveyor's Office, Sheffield.
1904 May 28	NICHOLLS, R.	Borough Engineer's Office, Southampton.
1896 June 25	NIGHTINGALE, C. F.	"Endellion," Buchanan Road, Walsall.
1905 Sep. 23	NIGHY, J.	"Highcliffe," Fulwich Road, Dartford.
*p*1905 Jan. 28	OWEN, J., A.M.Inst.C.E. ..	Engineer's Department, L.C.C., Spring Gardens, S.W.
1901 Aug. 24	OXBERRY, F. W.	Borough Engineer, Kendal.
1899 Oct. 21	PALMER, G. F.	111 Victoria Road, Charlton, S.E.
1901 Feb. 6	PALMER, W. L. F., Assoc. M. Inst. C.E.	City Engineer's Office, Bristol.
1906 Dec. 15	PARKER, E.	City Engineer's Office, Carlisle.
1904 May 28	PARKER, J.	9 Winchester Rd., Ilford, Essex.
1906 June 28	PARSONS, A. S.	Borough Surveyor's Office, Aston Manor, Birmingham.
1906 Dec. 15	PEACOCK, J. L.	Sewage Works Contract, Mayfield, Sussex
1906 June 28	PEARCE, W. H.	Borough Engineer's Office, Southend-on-Sea.
1904 June 25	PEARSON, T. G.	Town Hall, Barrow-in-Furness.
1896 Feb. 22	PERKINS, T. L., A.M. Inst.C.E.	P. W. D., Hong Kong.

ASSOCIATES.

* *Those Associates against whose names a star is placed have obtained the certificate of the Association.*

G *signifies elected as Graduate.*
TA *transferred to Associate Class.*

Date of Election and Transfer.		
1906 June 28	*Ash, H. J.	Chief Engineering Assistant, Council Offices, Nuneaton.
1901 Oct. 19	Ashbee, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1906 May 26	*Ballard, W. E.	Assistant Engineer, Council Offices, King's Heath, near Birmingham.
1904 Sept. 17	Bell, C. D., B.Sc. (*Vict.*)	Borough Engineer's Office, Barrow-in-Furness.
1906 Dec. 15	Belsher, B. J.	Assistant Borough Engineer, Stepney.
G1897 July 31 TA1901 Oct. 19	*Bentley, J. H., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Oldham.
G1904 May 28 TA1905 June 22	*Berridge, H. M. K., Assoc. M. Inst. C.E.	Assistant Surveyor, Council Offices, Long Eaton.
G1898 June 30 TA1901 Oct. 19	*Best, H. Storr	Assistant Engineer, Council Offices, Beckenham, S.E.
G1893 June 24 TA1902 Nov. 8	*Birch, J.	Deputy Surveyor, Public Offices, East Ham.
1903 Jan. 17	*Booth, E. W., A. M. Inst. C.E.	Engineering Assistant, Town Hall, Croydon.
G1899 June 10 TA1905 Jan. 28	*Bradshaw, A. S.	Deputy Borough Engineer, Bedford.
G1898 June 30 TA1903 June 25	*Briscoe, J. T.	Deputy Engineer, Council Offices, Enfield.
1903 July 25	*Bromly, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
1902 Jan. 25	Brookes, A. E.	Assistant County Surveyor, Worcester C.C. Breedon Cross, King's Norton, Birmingham.
1902 Jan. 25	Brown, H. A.	Assistant Borough Surveyor, Town Hall, Fulham, S.W.
1904 May 28	*Burton, W. E. H., Assoc. M. Inst. C.E.	Chief Engineering Assistant, County Architect's Office, Wakefield.
1904 Sept. 1	Carson, W. H., Assoc. M. Inst. C.E.	City Engineer's Office, Glasgow, N.B.
1904 May 28	Carter, E. W. A.	Assistant City Surveyor, Guildhall, Gloucester.
G1890 Sept. 13 TA1902 Sept. 6	*Catchpole, H.	Deputy Engineer, Council Offices, Finchley.
G1895 May 25 TA1902 May 10	*Clark, A. H. F.	District Engineer, P.W.D., Ceylon.

Date of Election and Transfer.		
G1894 July 7 TA1904 Sept. 17	*Claypoole, A. H., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1898 Dec. 17 TA1902 Mar. 22	*Clews, C. A.	Engineering Assistant, Borough Surveyor's Office, Derby.
G1899 June 29 TA1902 Jan. 25	*Collinge, T. P., A.M. Inst. C.E.	Deputy City Engineer, Town Hall, Carlisle.
1905 May 27	Collins, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
G1897 Feb. 13 TA1901 Oct. 19	*Collis-Adamson, A. C.	Assistant Borough Engineer, Hornsey, N.
1904 Oct. 11	Connor, C.	c/o W. Kennedy, Ltd., 25 Victoria Street, Westminster.
1903 May 16	Cooke, J. E.	Assistant Borough Engineer, Town Hall, Islington.
G1900 May 19 TA1901 Oct. 19	*Coombs, C. A.	Engineering Assistant, Town Hall, Burton-on-Trent.
G1899 Oct. 21 TA1902 Nov. 8	*Cowan, G.	District Surveyor, Town Hall, Portsmouth.
G1901 Aug. 24 TA1901 Oct. 19	*Cox, A. L.	City Surveyor's Office, Manchester.
1905 Mar. 4	*Cox, C. L.	Assistant Engineer, Municipal Offices, Colombo.
1902 Jan. 25	Crook, W. E.	Chief Engineering Assistant, Middlesex C.C. Guildhall, Westminster.
1906 Nov. 3	Cross, W. G.	Assistant Borough Surveyor, Tunbridge Wells.
1901 Oct. 19	*Croxford, C. H.	Chief Engineering Assistant, Town Hall, Wood Green, N.
G1903 Dec. 12 TA1905 May 27	*Debney, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
1904 Aug. 19	De Kretser, H. K.	District Engineer, P. W. D., Colombo, Ceylon.
G1891 Sept. 12 TA1902 Sept. 6	*Dolamore, F. P.	Deputy Borough Engineer, Bournemouth.
1904 Aug. 12	Donald, R. B., A.M.Inst.C.E.	Resident Engineer's Office, Sewage Disposal Works, Huddersfield.
1906 June 28	*Dresden, W. J.	Chief Engineering Assistant, Town Hall, Battersea.
G1899 June 29 TA1905 June 22	*Dyer, R. H.	Assistant Borough Engineer, Southend-on-Sea.
G1898 Dec. 17 TA1901 Dec. 7	*Ellison, D., A.M.Inst.C.E.	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25	*Endsor, H. A.	Surveyor, Rural District Council, Keynsham, Bristol.
1904 Aug. 27	Forbes, W.	Burgh Engineer's Office, Edinburgh, N.B.
G1899 Oct. 21 TA1903 July 25	*Foster, H. H.	Assistant Surveyor, Borough Surveyor's Office, Wandsworth. 215 High Rd., Balham.

Date of Election and Transfer.		
G1901 June 8 TA1901 Oct. 19	*Fowlds, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Keighley.
G1901 May 11 TA1902 Jan. 25	*Gair, J.	Assistant Borough Surveyor, Town Hall, Hammersmith, W.
P1903 Mar. 21	Galbraith, A. R., A.M. Inst. C.E.I.	District Surveyor, Town Hall, Portsmouth.
1905 June 22	*Gammage, E. J.	Borough Surveyor's Office, Dudley.
G1898 Jan. 15 TA1903 Jan. 17	*Godfrey, C. H., A.M. Inst. C.E.	Assistant Engineer, Municipal Offices, Shanghai.
1905 June 22	*Goode, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 TA1902 May 10	*Goodfellow, H.	Chief Engineering Assistant, Town Hall, Southport.
G1894 Jan. 13 TA1902 July 10	*Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Aberdeen, N.B.
1903 July 25	Gray, A. R.	Engineering Assistant, Council House, Birmingham.
G1893 Jan. 14 TA1901 Oct. 19	*Greenwood, J. P., A.M. Inst. C.E.	Deputy Borough Surveyor, Town Hall, Burnley.
1904 Aug. 9	Greig, J. M. M.	7 Hartington Place, Carlisle.
1902 Mar. 22	Hadfield, W. J.	Deputy City Surveyor, Town Hall, Sheffield.
G1897 June 19 TA1901 Oct. 19	*Haigh, W. H., A.M. Inst. C.E.	Chief Engineering Assistant, Town Hall, Cardiff.
1903 June 6	Harding, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1899 Oct. 21 TA1902 May 10	*Harper, A.	Deputy Borough Surveyor Town Hall, St. Helen's, Lancs.
1906 Mar. 3	*Haskins, W. J.	Assist. Superintendant, P.W.D., Singapore, S.S.
1903 June 6	Heap, H., A. M. Inst. C.E. ..	16 Manor Avenue, Grimsby.
G1903 Jan. 17 TA1905 Apr. 29	*Heath, J. R.	Assistant Borough Surveyor, Burslem.
1904 Aug. 26	Henderson, R. T...	City Engineer's Office, City Chambers, Glasgow, N.B.
G1905 Dec. 9 TA1906 Dec. 15	*Hewitt, F.	Borough Road Surveyor, Southport.
G1900 Mar. 10 TA1902 May 10	*Hinchsliff, E. R...	Deputy Surveyor, Council Offices, Barry.
1905 Jan. 28	Hipwood, J. W., A. M. Inst. C.E.	Chief Assistant, Borough Eng. Office, Southend-on-Sea.
G1900 Aug. 25 TA1902 Mar. 22	*Holloway, W. C.	Chief Engineering Assistant, Council Offices, Kettering.
G1897 July 31 TA1902 Nov. 8	*Jenkins, R. J.	Chief Assistant, Town Hall, Portsmouth.
G1900 June 16 TA1901 Oct. 19	*Jerram, G., A.M. Inst. C.E.	Assistant Surveyor, Town Hall, Walthamstow, N.E.
G1897 June 19 TA1902 Jan. 25	*Johnston, R. W.	Deputy Borough Engineer Town Hall, Birkenhead.

Date of Election and Transfer.		
G1901 June 8 TA1904 Mar. 26	*Jones, H. O.	Assistant Borough Engineer, Folkestone.
1902 May 10	Kerr, A. M., B. Sc. (*Vict.*), A.M. Inst. C.E.	Assistant Borough Engineer, Town Hall, Warrington.
G1896 June 25 TA1906 Dec. 15	*Kieser, W. H. G., Assoc. M. Inst. C.E.	District Surveyor, Bristol.
1906 Mar. 3	*Kinnear, C. F. A...	City Chambers, Edinburgh.
1904 Feb. 27	Kirby, H. C.	Town Engineer's Department, Pretoria, South Africa.
1901 Dec. 7	Lashmore, E. W., Assoc. M. Inst. C.E.	District Surveyor, Alma Vale Road, Clifton, Bristol.
G1903 June 25 TA1906 Dec. 15	*Lees, H. B.	District Eng., Jaffna, Ceylon.
G1901 May 11 TA1901 Oct. 19	*Lismer, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
1904 Sept. 6	McInnes, D.	City Engineer's Office, Glasgow, N.B.
1902 Nov. 8	McKenzie, L. S., A.M.Inst.C.E.	District Surveyor, 63 Queen Square, Bristol.
1903 Mar. 21	Manning, W. R., A. M. Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
1904 Aug. 4	Marr, G. E.	District Offices, Hamilton, N.B.
1903 Jan. 17	Marshall, L. P., M. Inst. C.E.	Northern Outfall Works, Beckton, E.
G1900 Apr. 21 TA1901 Dec. 7	*Miller, G. F.	Chief Assistant, Borough Engineer's Office, Hastings.
G1898 Dec. 17 TA1901 Oct. 19	*Mitchell, G.	Tofany Storage Reservoir, Kilco Post Office, Co. Down, Ireland.
1904 Sept. 19	Morrison, A. W.	Burgh Engineer's Office, Edinburgh, N.B.
G1901 Aug. 24 TA1902 Nov. 8	*Neave, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
1904 Aug. 17	Oliver, J. R...	Burgh Engineer's Department, Edinburgh, N.B.
G1895 June 27 TA1902 July 10	*Openshaw, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
G1902 Mar. 22 TA1904 Oct. 29	*Parr, J. E., A.M.Inst.C.E. ..	Chief Assistant, Engineer's Office, Handsworth, Birmingham.
1904 Sept. 5	Paterson, J. B.	Deputy Burgh Surveyor, Partick, N.B.
G1900 June 16 TA1902 Feb. 22	*Percival, W.	Assistant Borough Surveyor, Court House, Longton, Staffs.
1906 Jan. 20	*Perkins, G. S.	Assistant Surveyor to the Urban District Council, Teddington.
G1895 Jan. 19 TA1901 Oct. 19	*Perkins, J.	Engineering Assistant, Council House, Birmingham.

Date of Election and Transfer.		
G1899 Oct. 21 / TA1904 June 25	*PLANT, W., A. M. Inst. C.E.	Borough Engineer's Office, Leicester.
1903 Dec. 12	*RACE, A...	Chief Assistant, Borough Engineer's Office, Barrow-in-Furness.
1902 Mar. 22	RANSOM, W., A. M. Inst. C.E.	Chief Assistant Surveyor, Worcester. Midhurst, Bath Road, Worcester.
1904 Aug. 31	REID, M...	Burgh Engineer's Office, Paisley, N.B.
1906 May 26	*ROBINSON, W. P., B.Sc.(Vict.), Assoc. M. Inst. C.E.	Clarence House, The Peth, Durham.
G1903 June 6 / TA1904 Mar. 26	*ROSEVEARE, L., A.M.Inst.C.E.	Council House, Birmingham.
1902 Nov. 8	ROWBOTTOM, J.	Chief Assistant, Borough Surveyor's Office, Ashton-under-Lyne.
1903 June 6	SADLER, F.	Deputy Surveyor, Council Offices, Acton.
G1894 Oct. 20 / TA1902 May 10	*SAVAGE, E. B., A.M.Inst. C.E.	Engineering Assistant, Council House, Birmingham.
1902 Nov. 8	*SHACKLETON, W., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Hanley.
1905 May 27	SHERREN, A. O., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Dover.
G1899 Dec. 16 / TA1901 Oct. 19	*SLATER, F. J.	Assistant Surveyor, Town Hall, Camberwell, S.E.
1904 May 28	*SMITH, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.
1906 Apr. 28	SMITH, H. J. T.	Assistant Engineer, Municipal Offices, Calcutta.
1901 Dec. 7	SPURR, F. W.	Chief Assistant, City Engineer's Office, York.
G1895 Jan. 19 / TA1901 Oct. 19	*STEELE, W. J., A.M. Inst. C.E.	Deputy City Engineer, Bristol.
1904 Aug. 22	STEPHEN, T. M.	District Offices, Hamilton, N.B.
G1903 June 25 / TA1904 Feb. 27	*STEVENS, H. L., A.M. Inst. C.E.	Chief Assistant Engineer, Council Offices, Watford.
1904 Apr. 30	STORY, G. E.	Surveyor, Western District, Town Hall, Sheffield.
1903 Mar. 21	SUTCLIFFE, H.	Deputy Borough Engineer Town Hall, Huddersfield.
1905 Sep. 23	SWARBRICK, G.	Deputy Borough Surveyor, Swansea.
G1898 Dec. 17 / TA1902 Jan. 25	*TAYLOR, J.	Borough Engineer, Walsall.
G1900 Dec. 15 / TA1903 May 16	*TAYLOR, P.	Chief Engineering Assistant, Council Offices, Ilford.
G1899 June 10 / TA1905 Sep. 23	*THACKERAY, J. R...	Deputy Borough Surveyor, Eastbourne.
1904 June 25	*THOMPSON, W., A.M.Inst.C.E.	Deputy Borough Engineer, Burton-on-Trent.

Date of Election and Transfer.		
1905 Jan. 28	WALDRAM, B. E.	Assistant Borough Engineer, Town Hall, Woolwich.
G1904 May 28 TA1904 Dec. 3	*WALTON, J. S.	Borough Engineer's Office, Torquay.
1905 Sep. 23	WARD, A. W., A.M. Inst. C.E.	Assistant Borough Engineer, Northampton.
1903 July 25	*WATMORE, JAS.	Assistant Surveyor, Council Offices, Aldershot.
G1899 June 10 TA1902 Mar. 22	*WEIR, J. S., A.M. Inst. C.E.	Chief Assistant, Borough Surveyor's Office, Halifax.
G1902 July 10 TA1905 Jan. 28	*WHITAKER, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.
1903 May 16	WHITE, W. H. J., A. M. Inst. C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
G1902 Nov. 8 TA1904 Feb. 27	*WIBBERLEY, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
1902 Mar. 22	WILLIAMS, H. B.	Chief Assistant, Borough Engineer's Office, Workington.
1902 July 10	WILLIAMS, J.	Assistant Borough Surveyor, Town Hall, Hampstead, N.W.
G1901 Dec. 7 TA1906 Dec. 15	*WILLIAMS, J. H.	Deputy Borough Engineer, Todmorden.
1906 Apr. 28	WILLIAMS, S. G., Assoc. M. Inst. C.E.	Assistant Engineer, Municipal Offices, Singapore, S.S.
G1898 June 30 TA1901 Dec. 7	*WILLIS, E., Assoc. M. Inst. C.E.	Chief Engineering Assistant, Council Offices, Willesden, N.W.
1903 June 6	WILSON, A., B.Sc. (*Lond.*), Assoc. M. Inst. C.E.	Depto. Via y Obras, F. C. Sud., Buenos Aires.
G1898 June 30 TA1901 Dec. 7	*WILSON, F., A.M. Inst. C.E.	District Surveyor, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19	*YARWOOD, H.	Assistant Borough Surveyor, Town Hall, Rochdale.
G1901 June 8 TA1902 Feb. 22	*YELLAND, T.	Assistant Borough Engineer, Bury.

GRADUATES.

All Graduates hold the Certificate of the Association.

Date of Election.		
1906 April 28	ANDREWS, S. H.	28 Penhurst Road, South Hackney, N.E.
1893 Oct. 2	BALL, J. B., M. Inst. C.E. ..	Engineer's Office, L.D. & E.C. Railway, Chesterfield.
1905 June 22	BARKER, H. W.	Council House, Handsworth, Birmingham.
1890 Mar. 29	BAYLEY, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
1897 July 31	BEARD, E. T., M. Inst. C.E...	4 The Crescent, Scarborough.
1906 June 28	BEAUMONT, R. H...	Greno Lodge, Grenoside, near Sheffield.
1906 Dec. 15	BELL, G. H.	37 Glanmor Crescent, Swansea.
1906 May 26	BENTLEY, W...	468 St. Helens Road, Bolton, Lancs.
1902 Mar. 22	BERRINGTON, E. E. W... ..	28 Victoria Street, Westminster, S.W.
1903 Dec. 12	BIKER, W. J. E.	Municipal Offices, Harrogate.
1900 June 16	BLAKEWAY-PHILLIPS, R. ..	City Engineer's Office, Westminster, S.W.
1901 Aug. 24	BLANCHARD, R.	Town Hall, Leicester.
1889 June 8	BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
1905 Jan. 28	BRADLEY, C. G.	Borough Engineer's Office, Leigh.
1896 June 25	BRUCE, W...	Burgh Engineer's Office, Edinburgh.
1889 July 4	BRYANS, J. G., Assoc. M. Inst. C.E.	Sectional Engineer, Palermo Station, F.C.P., Buenos Aires.
1905 May 27	BULL, E. M.	Council Offices, Finchley, N.
1899 June 29	BURGESS, R. W.	Town Hall, Stratford, E.
1903 June 6	BUTLER, H. L.	Surrey House, Surrey Lane, Battersea.
1905 June 22	BUTLER, R.	"Woodthorpe," Prospect Road, Tunbridge Wells.
1904 June 25	BUTT, E. E. W.	Council Offices, Birmingham.
1905 Dec. 9	BUTTERWORTH, G. L.	Surveyor, Isle of Thanet U.D.C., Birchington-on-Sea.
1902 July 10	BUTTON, F. E.	City Surveyor's Office, Manchester.
1906 June 28	CAPLEN, L.	Rusthall, Tunbridge Wells.
1903 Dec. 12	CARTER, S. F. R.	Town Hall, Hounslow.
1897 June 19	CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
1906 May 26	CASTLE, J. H...	27 Highbury Park, Highbury, N.
1906 Dec. 15	CATHCART, A. B.	4 St. Mary's Square, Paddington, W.
1904 May 28	CATTLIN, O.	Borough Surveyor's Office, 197 High Holborn, W.C.
1904 Dec. 3	CLARKE, R. E.	Public Offices, Arnold, Notts.
1894 July 7	CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
1903 Dec. 12	COCHRANE, J.	15 Ure Place, Montrose Street, Glasgow.

Date of Election.		
1906 May 26	Conway, F. J. K.	Borough Engineer's Office, Town Hall, Birkenhead.
1906 Dec. 15	Couzens, R. H.	City Engineer's Office, Carlisle.
1904 May 28	Cowlishaw, H. H.	43 Lennard Road, Penge, S.E.
1904 Jan. 23	Cox, C. E.	Windmill Hill, Cradley. Cradley Heath.
1906 Jan. 20	Crabb, H. R.	Council House, Birmingham.
1897 June 19	Creswell, W. T.	11 Victoria Street, S.W.
1906 Sept. 22	Criswell, W.	Contractor's Office, Derwent Valley Waterworks, Bamford, Sheffield.
1892 July 11	Cross, F. W., A.M. Inst. C.E.	"Ingleside," Clifton Road, Sutton Coldfield.
1905 June 22	Cross, W. G.	25 Arundel Road, Tunbridge Wells.
1903 June 6	Cubitt, H. W.	County Hall, Spring Gardens, S.W.
1905 Jan. 28	Darby, A. E.	194 Bishton Lane, Bolton.
1906 Jan. 20	Darby, H.	1 Leighton Road, Ealing.
1901 June 8	Davidge, W. R., Assoc. M. Inst. C.E.	London County Council Offices, 19 Charing Cross Road, W.C.
1902 July 10	Dawkins, F.	Borough Surveyor's Office, Bournemouth.
1902 July 10	Deeley, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
1898 June 30	Dent, J. P.	1 Woodside Terrace, Nelson, Lancashire.
1904 May 28	Draper, J.	Council House, Handsworth, Birmingham.
1903 Oct. 17	Duncan, L. G.	10 Hanover Buildings, Southampton.
1906 May 26	Eayrs, T. W.	"Thornlea," Beeches Road, West Bromwich.
1906 Dec. 15	Edwards, J. H.	9 Talbot Road, Wrexham.
1898 Dec. 17	Essex, E. H., A.M. Inst. C.E.	Town Hall, Leyton, N.E.
1905 May 27	Farrar, W.	Town Hall, Todmorden.
1886 Sept. 11	Fenton, W. C.	14 St. James' Row, Sheffield.
1900 June 16	Fisher, R.	37 Inman Road, Harlesden, N.W.
1903 July 25	Ford, J.	Lower House, Branscombe, Axminster.
1903 Feb. 21	Foster, J. W.	Town Hall, Bradford.
1903 June 6	Foster, W. A.	Park View, Manchester Road, Accrington.
1903 June 25	Gettings, S. S., Assoc. M. Inst. C.E.	Resident Engineer's Office, Waterworks, Moreton-in-the-Marsh, Glos.
1899 June 10	Gibson, W. S.	"Everitta," Finchley Lane, N.W.
1888 July 12	Glass, S. N., A.M. Inst. C.E.	16 Ravenscroft Road, Chiswick.
1905 Jan. 28	Goddard, F. B.	87 Cicada Road, Wandsworth.
1906 Dec. 15	Goldsmith, W. H.	Town Hall, Hull.
1905 June 22	Greenhill, F. G.	"Moorhaven," Headstone Road, Harrow.
1906 May 26	Griffiths, H.	Borough Surveyor's Office, Crewe.
1898 Jan. 15	Grimley, F. C.	Depôt Barracks, Harwich.
1904 Dec. 3	Grove, A.	1 Parkfield Terrace, Stourbridge.
1905 June 22	Gunson, E., A.M. Inst. C.E.	c/o Grindlay & Co., Calcutta.

Date of Election.		
1905 June 22	HADFIELD, J. R.	Borough Surveyor's Office, Bedford.
1904 Jan. 23	HARKNESS, J.	20 Duke Street, Edinburgh.
1901 June 27	HARLOW, W. W. R., Assoc. M. Inst. C.E.	City Engineer's Office, Carlisle.
1901 June 8	HARRIS, K. J. S.	Borough Surveyor, Wisbech.
1906 Mar. 3	HARRISON, J.	53 Ormerod Road, Burnley.
1903 June 25	HARRISON, P. T.	Town Hall, Fulham.
1905 Oct. 28	HASSALL, J.	Resident Engineer's Office, Western Valleys (Mon.) Sewerage Board, Bassaleg, Mon.
1904 May 28	HATTON, J	1 Mill Cliff, Buxton, Derbyshire.
1893 Jan. 14	HELLAWELL, O.	Town Hall, Withington, Manchester.
1906 June 28	HEWES, G. W.	27 Williams Road, Burnley.
1906 Dec. 15	HEWITT, A. C.	"Nutfield," Scarborough Road, Filey, Yorkshire.
1896 June 25	HILLS, O. C.	360 Mare Street, Hackney, N.E.
1900 June 16	HOBSON, E.	117 Oakland Road, Hillsborough, Sheffield.
1906 Mar. 3	HOLDEN, R. B.	Town Hall, Oldham.
1888 July 12	HOUGHTON, J.	King's Heath, Birmingham.
1904 Oct. 29	HOWELL, H. H.	63 Queen Square, Bristol.
1903 Jan. 17	HOWELLS, D. P.	16 Ropewalk, Neath, S. Wales.
1899 June 10	HUTCHINGS, W. A...	Springfield Brewery, Wolverhampton.
1904 Dec. 3	HUTCHINSON, H. F.	2 Queen's Road, Chorley.
1903 Dec. 12	JACQUES, H. S.	Municipal Offices, Cheltenham.
1906 Dec. 15	JENKINSON, F. C.	29B High Street, Rotherham.
1905 Jan. 28	JENNINGS, W...	Borough Engineer's Office, Leyton.
1903 July 25	JONES, T.	53 Princes Street, Southport.
1906 Dec. 15	JONES, T.	Townfield Road, West Kirby.
1895 Oct. 19	JULIAN, J.	Borough Surveyor's Office, Cambridge.
1906 May 26	KING, J. S.	Council Offices, Friern Barnet, New Southgate, N.
1903 June 25	KNIGHT, R. B.	Council Offices, Bromley, Kent.
1903 June 25	KNOWLES, G. P., A.M. Inst. C.E.	39 Victoria Street, S.W.
1905 Dec. 9	LAKE, W. S.	Borough Engineer's Office, Plymouth.
1906 Dec. 15	LEES, R. B.	99 Antrobus Street, Congleton, Cheshire.
1904 June 25	LEWIS, H. M.	Town Hall, Staines.
1904 Dec. 3	LINE, H. W.	L.C.C., 19 Charing Cross Road, S.W.
1906 June 28	LUDFORD, E. W.	Borough Surveyor's Office, Town Hall, Hammersmith.
1905 Sep. 23	LYDDON, A. J.	Borough Engineer's Office, Town Hall, Reading.
1905 May 27	MCARD, A. J.	Edge Hill, Whitehaven.
1900 Dec. 15	MACDONALD, K. G.	13 Charles Street, St. James's, S.W.
1906 Dec. 15	MACKENZIE, W. H.	Les Rosiers, Holdenhurst Road, Bournemouth.

Date of Election.		
1905 May 27	MAITLAND, W. H.	Town Hall, Hoylake, Cheshire.
1903 June 25	MANN, E. E.	Borough Engineer's Office, Southampton.
1904 May 28	MANSFIELD, F.	1 Castle Green Villas, Mill Street, Hereford.
1903 Jan. 17	MARRIAN, H. G., Assoc. M. Inst. C.E.	City Surveyor's Office, Manchester.
1906 April 28	MARSH, F. E.	Municipal Engineer's Office, Singapore, S.S.
1894 Jan. 13	MARTIN, E. B., A.M.Inst.C.E.	City Engineer's Office, Leeds.
1903 Jan. 17	MASTERS, W. H.	Glencairn, Arthur Road, Southampton.
1905 Jan. 28	MATHEW, H. B.	Borough Engineer's Office, Dover.
1906 Dec. 15	MATTHEWS, R. H.	178 High Road, South Tottenham, N.
1905 May 27	MATTHEW, S.	South Villa, Crow Nest Park, Dewsbury.
1900 June 16	MATTINSON, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
1904 May 28	MILLAR, P.	Borough Engineer's Office, Southampton.
1906 May 26	MILNER, J. D., A.M.Inst.C.E.	City Engineer's Office, Hull.
1901 Oct. 19	MILNES, B.	Town Hall, Birkenhead.
1905 May 27	MINORS, E.	City Engineer's Office, Worcester.
1905 June 22	MORGAN, G. L.	11 The Parade, Pontypridd.
1899 June 10	MOSS, P. A.	153 Highbury Hill, Highbury, N.
1902 July 10	NATHANIELSZ, A. H., Assoc. M. Inst. C.E.	P.W D., Bungalow, Wegambo, Ceylon.
1904 Dec. 3	NEEDHAM, J. E.	Municipal Engineer's Office, Shanghai.
1906 Jan. 20	NEWMAN, W. W.	Borough Offices, Poole.
1906 Jan. 20	NEWSOME, S. H.	City Surveyor's Office, Sheffield.
1904 May 28	NICHOLLS, R.	Borough Engineer's Office, Southampton.
1896 June 25	NIGHTINGALE, C. F.	"Endellion," Buchanan Road, Walsall.
1905 Sep. 23	NIGHY, J.	"Highcliffe," Fulwich Road, Dartford.
p1905 Jan. 28	OWEN, J., A.M.Inst.C.E. ..	Engineer's Department, L.C.C., Spring Gardens, S.W.
1901 Aug. 24	OXBERRY, F. W.	Borough Engineer, Kendal.
1899 Oct. 21	PALMER, G. F.	111 Victoria Road, Charlton, S.E.
1901 Feb. 6	PALMER, W. L. F., Assoc. M. Inst. C.E.	City Engineer's Office, Bristol.
1906 Dec. 15	PARKER, E.	City Engineer's Office, Carlisle.
1904 May 28	PARKER, J.	9 Winchester Rd., Ilford, Essex.
1906 June 28	PARSONS, A. S.	Borough Surve or's Office, Aston Manor, Birmingham.
1906 Dec. 15	PEACOCK, J. L.	Sewage Works Contract, Mayfield. Sussex
1906 June 28	PEARCE, W. H.	Borough Engineer's Office, Southend-on-Sea.
1904 June 25	PEARSON, T. G.	Town Hall, Barrow-in-Furness.
1896 Feb. 22	PERKINS, T. L., A.M. Inst.C.E.	P. W. D., Hong Kong.

Date of Election.		
1903 Feb. 21	Perrott, E. S.	6 Elliston Road, Redland, Bristol.
1903 Dec. 12	Persey, W. C.	Town Hall, Barrow-in-Furness.
1902 July 10	Phillips, R.	41 Okehampton Road, Willesden, N.W.
1901 Aug. 24	Pickin, W. H.	L.C.C. Works Department, Belvedere Road, Lambeth, S.E.
1904 May 28	Piercy, M. A.	41a Burnbury Road, Balham, S.W.
1906 Dec. 15	Pool, H..	10 Jasper Street, Hanley, Staffs.
1888 Sept. 15	Pritchard, T., M. Inst. C.E.	264 Gresham House, Old Broad Street, E.C.
1898 June 30	Quick, A. H., Assoc. M. Inst. C.E.	"Inverness," Malvern Road, Thornton Heath.
1904 Dec. 3	Quirk, J. J.	Borough Surveyor's Office, Swindon, Wilts.
1900 Dec. 15	Rawstron, C. O.	Surveyor's Office, Rural District Council, Lichfield, Staffs.
1901 June 8	Read, F., Assoc. M. Inst. C.E.	Public Offices, Pentre, Rhondda, Glam.
1902 Nov. 8	Redford, W. T.	Town Hall, Eccles, Lancs.
1899 Mar. 25	Richards, E. P.	Engineer's Office, Derwent Valley Water Board, Bamford, via Sheffield.
1904 May 28	Richmond, W. S.	Municipal Offices, Highgate, N.
1900 Feb. 10	Ross, D.	Brynmenyn, near Aberkenfig, Glam., South Wales.
1900 June 16	Rousell, A. J., A.M.Inst.C.E.	Borough Engineer's Office, Worthing, Sussex.
1905 June 22	Sagar, J. H.	Council Offices, High Street, Poplar.
1906 May 26	Sawdon, J. S...	Municipal Buildings, Cheltenham.
1904 May 28	Schlund, W. T. S.	"Dulce Domum," Cleanthus Road, Shooter's Hill, S.E.
1902 July 10	Shepherd, G. G.	Town Hall, Ilford.
1906 June 28	Sherwood, A. F.	Borough Surveyor's Office, Town Hall, Hammersmith.
1899 June 29	Simms, F.	Town Hall, Sheffield.
1905 May 27	Sissons, F. P.	Assistant Borough Engineer, Hanley.
1905 Oct. 28	Slater, E. A., A.M. Inst. C.E.	201 Malden Road, Colchester.
1906 June 28	Small, L. J.	Council Offices, Broadstairs.
1906 Jan. 20	Smith, A.	North Road House, Fareham, Hants.
1898 Jan. 15	Smith, G. H.	1 Worcester Road, Wimbledon, S.W.
1906 May 26	Smith, W. B.	Public Offices, Hampton, Middlesex.
1905 Mar. 4	Snape, A. E.	Resident Engineer's Office, L.C.C. Main Drainage, Elliott Place, Blackheath, S.E.
1898 June 30	Spink, J.	City Surveyor's Office, Manchester.
1899 June 29	Stanton, F. W. S., A.M. Inst. C.E.	28 Baldwin Street, Bristol.
1904 June 25	Stephenson, W. E., A.M.Inst. C.E.	City Engineer's Office, Leeds.

Date of Election.		
1906 Mar. 3	SUTCLIFFE, H.	158 Todmorden Road, Burnley.
1904 May 28	SUTHERLAND, D. S.	Hebe Cottage, Thynne Street, West Bromwich.
1898 June 30	SUTTON, W. F.	Water Department, Broad Street, Birmingham.
1906 June 28	TASMAN, H. E.	41 Highbury Road, Finchley, N.
1900 Dec. 15	TAYLOR, H. T.	3 North Terrace, Gt. Meols, Hoylake, Cheshire.
1902 July 10	TAYLOR, S.	Town Hall, Manchester.
1902 July 10	TOMLINSON, J. W., A.M. Inst. C.E.	St. Mary's Hall, Coventry.
1905 Sep. 23	TONGE, J. A.	125 Nottingham Road, Mansfield.
1900 June 16	TOWNER, H. V.	P.W.D., Singapore, Straits Settlements.
1900 June 16	TREMELLING, H., Assoc. M. Inst. C.E.	Borough Engineer's Office, Newport, Mon.
1903 Jan. 17	TRESEDER, F. H.	The Nurseries, Cardiff.
1904 May 28	TULLEY, G. W.	95 Slateford Road, Edinburgh.
1906 Sept. 22	TURTON, C.	Penkridge, near Stafford.
1905 Dec. 9	UNDERHILL, G. B.	St. Stephen's, Canterbury, Kent.
1904 May 28	VAREY, J. A.	Westhill House, Chapel Allerton, Leeds.
1905 May 27	VERNON, A.	Town Hall, Upper Street, Islington.
1906 June 28	WAINWRIGHT, H. C.	22 Haden Hill, Wolverhampton.
1902 Nov. 8	WALKER, A. H.	128 Prince of Wales Road, London, N.W.
1888 Jan. 14	WARD, F. D., A. M. Inst. C.E.	38 High Street, Welshpool.
1897 June 19	WEBB, F.	Town Hall, Chelsea.
1898 Jan. 15	WELLS, F. B., Assoc. M. Inst. C.E.	c/o The Great Southern Railway Co., Buenos Aires.
1902 Sept. 6	WEST, A. S.	Borough Engineer's Office, Harrogate.
1902 Jan. 25	WHITE, C. D...	Council Offices, Hanwell.
1901 June 8	WHITEFORD, E. H., A.M. Inst. C.E.	Engineer's Office, Derwent Valley Water Board, Bamford, near Sheffield.
1902 July 10	WILKINSON, F., A.M.Inst.C.E.	Town Hall, Rochdale.
1901 Aug. 24	WILKINSON, H. F., A.M. Inst. C.E.	Fulford House, The Crescent South Tottenham, N.
1901 June 27	WILLETT, A. J.	18 Castledine Road, Anerley, S.E.
1895 June 27	WILLIAMS, D. S.	c/o G. R. Strachan, 7 Victoria Street, S.W.
1900 Dec. 15	WILLS, A. J.	2881 Woodbrook Avenue, Druid Hill Park, Baltimore, Ma., U.S.A.
1901 Aug. 19	WILSON, H. B.	204 Spring Avenue, La Grange, Illinois, U.S.A.
1900 July 19	WRACK, W. P.	117 High Street, Poplar, E.
1904 June 25	WRIGHT, F. W.	Resident Engineer's Office, Sewerage Works, Camberley, Surrey.
1906 May 26	WRIGHT, W.	14 Ventnor Road, Portland, Dorset.
1906 June 28	WRIGLEY, G. E.	Sandal Terrace, Sowerby Bridge.

STANDING COMMITTEES.

GENERAL PURPOSES COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. P. BARBER (Islington), *Chairman.*

W. N. Blair (St. Pancras).
J. A. Brodie (Liverpool).
J. W. Cockrill (Great Yarmouth).
A. E. Collins (Norwich).
C. H. Cooper (Wimbledon).
A. Creer (York).
A. Fidler (Northampton).
A. D. Greatorex (West Bromwich).
W. Harpur (Cardiff).
Chas. Jones (Ealing).
H. T. Wakelam (Middlesex Co.)
C. F. Wike (Sheffield).
T. H. Yabbicom (Bristol).

FINANCE COMMITTEE.

THE PRESIDENT (*ex-officio*).
T. H. YABBICOM (Bristol), *Chairman.*

J. A. Brodie (Liverpool).
A. E. Collins (Norwich).
A. Creer (York).
W. Harpur (Cardiff).
T. W. A. Hayward (Battersea).
Chas. Jones (Ealing).
P. H. Palmer (Hastings).
R. Read (Gloucester).

PARLIAMENTARY COMMITTEE.

THE PRESIDENT (*ex-officio*).
J. S. PICKERING (Cheltenham), *Chairman.*

J. A. Brodie (Liverpool).
A. E. Collins (Norwich).
A. T. Davis (Shropshire County).
J. Dewhirst (Chelmsford Rural).
A. Fidler (Northampton).
A. D. Greatorex (West Bromwich).
F. Massie (Wakefield Rural).
P. H. Palmer (Hastings).
W. E. C. Thomas (Neath Rural).
C. F. Wike (Sheffield).

PAPER COMMITTEE.

THE PRESIDENT (*ex-officio*).
H. T. WAKELAM (Middlesex), *Chairman.*

C. H. Cooper (Wimbledon).
A. Creer (York).
A. D. Greatorex (West Bromwich).
T. W. A. Hayward (Battersea).
A. B. McDonald (Glasgow).
J. S. Pickering (Cheltenham).
R. Read (Gloucester).
R. J. Thomas (Bucks Co.).

THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

THIRTY-THIRD ANNUAL MEETING.

LONDON, *June* 28, 29, *and* 30, 1906.

THE Members assembled in the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.

The Secretary read the Minutes of the last Annual General Meeting, which were confirmed and signed.

The Secretary read the Council's Annual Report.

ANNUAL REPORT.

The Council have pleasure in presenting their Annual Report.

DISTRICT MEETINGS.

Since the last Annual General Meeting, eight District Meetings have been held. At Swansea (South Wales district) on July 15, 1905; at Ayr (Scottish district) on August 26, 1905; at Kettering (Midland district) on September 2, 1905; at Tottenham (Home district) on October 21, 1905; at Newmarket (Eastern district) on May 5, 1906; at Battersea (Metropolitan district) on May 19, 1906; at Scarborough (Yorkshire district) on June 1 and 2, 1906; and at Berwick (Scottish district) on June 15 and 16, 1906.

THE ROLL OF THE ASSOCIATION.

During the financial year ending April 30 last, Mr. Charles Hawkesley, Past-President Inst. C.E., was elected as an Hon. Member.

73 new Members, consisting of 27 ordinary Members, 11 Associates, and 35 Graduates, have joined the Association. Ten Members have resigned; twenty names have been written off or not re-elected; and the Council record with regret the deaths of Messrs. James Mansergh (Hon. Member), C. H. Lowe (Past-President), J. Price (Vice-President), B. Bell, W. H. R. Crabtree, W. H. Hopkinson (Hon. Secretary, Yorkshire district), G. E. Hull, F. J. Morris, and C. D. M. Trinder.

The numbers on the roll of the Association at the close of the year were 10 Honorary Members, 844 Ordinary Members, 138 Associates, and 180 Graduates—making a total of 1172.

The Council have transferred 1 Associate and 3 Graduates to the class of Members, and 5 Graduates to the class of Associates, these gentlemen occupying positions qualifying them under the Articles for transfer.

TABLE SHOWING NUMERICAL INCREASE.

—	1900 to 1901.	1901 to 1902.	1902 to 1903.	1903 to 1904.	1904 to 1905.	1905 to 1906.
Hon. Members	10	9	8	10	10	10
Members	808	823	810	813	852	844
Associates	..	58	83	93	123	138
Graduates	148	129	133	144	158	180
Total	966	1019	1034	1060	1143	1172

THE FINANCES.

The audited Balance-Sheet and Statement of Revenue and Expenditure, which accompanies this Report, shows an excess of Income over Expenditure, on April 30 last, of 32*l*. 5*s*. 11*d*. The Income includes the redemption of 200*l*. stock, the capital account being depleted by that amount. This is due to abnormal expenditure on (1) Membership certificates, 92*l*. 15*s*. 9*d*., and (2) The expenses of the By-law Committee, 117*l*. 16*s*. 10*d*.

EXAMINATIONS.

Since the last Report five examinations have been held. Ninety-four candidates have been examined, of whom 47 satis-

fied the examiners and received the Testamur of the Association. It is with much gratification that the Council observe the growing recognition which this department of the educational work of the Association is receiving both from Municipal Authorities and engineers.

Premiums.

The Council have awarded premiums of 5*l.* each to Mr. P. H. Palmer (Member) for his paper on "Reinforced Concrete," and Mr. A. R. Galbraith (Associate), for his paper on "Reinforced Concrete Piling"; and of 3*l.* to Mr. J. Owen (Graduate), for his paper on "Tramway Materials and Construction."

The New Council.

The Scrutineers, having examined the ballot lists, report the following gentlemen elected as the Council for the year 1906–7:

President.—Mr. J. Patten Barber.

Vice-Presidents.—Messrs. W. N. Blair, J. A. Brodie, and C. F. Wike.

Ordinary Members of Council.—Messrs. C. H. Cooper, A. Creer, H. A. Cutler, A. Fidler, A. D. Greatorex, W. Harpur, T. W. A. Hayward, E. P. Hooley, A. B. McDonald, P. H. Palmer, J. Paton, J. S. Pickering, R. Read, H. T. Wakelam, and A. E. White.

Hon. Secretary.—Mr. Charles Jones.

Hon. Treasurer.—Mr. Lewis Angell.

The Past-Presidents (ex-officio Members of the Council), are Messrs. A. T. Davis, and A. E. Collins. The elective past-Presidents are Messrs. J. Lobley, O. C. Robson, and T. H. Yabbicom.

It is gratifying to note that Mr. Harpur, past-President, has been returned to again serve the Association as an ordinary Member of Council.

Appointment of Assistant Secretary.

In view of the constantly increasing work of the Secretary's office, the Council have appointed Mr. H. A. Giles as Assistant Secretary.

Payment of Expenses.

In fulfilment of their promise made last year, the Council have pursued their efforts in this matter. Invitations have been addressed to various kindred Societies, and a joint Committee consisting of representatives of the Royal Sanitary Institute, the Institution of Gas Engineers, the Association of Waterworks Engineers, and this Association, has been formed, and is now engaged in drafting the necessary amendments of the Conferences Act to obtain, for all duly appointed officials, the same facilities in the matter of payment of expenses incurred in attending meetings as are now granted to the Clerk.

Payments to Members out of Loans.

The attention of your Council has been directed to the injustice done to Members by the condition attached by the Local Government Board to their sanction for loans for public works, i.e., that no payment may be made out of such loan to a salaried officer of the authority other than the Clerk, for work done in connection therewith. Your Council addressed an appeal to the Local Government Board pointing out such injustice, and praying for the removal of this unfair condition. The Board replied to the effect that they attach considerable importance to the condition, and are not prepared to dispense with it. Your Council trust, however, that an opportunity will be given them to personally lay their views before the President of the Local Government Board.

Surcharge of Professional Fees.

At the request of one of our Members, the Council addressed a letter of protest to the Local Government Board in reference to the action of one of their auditors in surcharging fees received for evidence given on behalf of a neighbouring local authority.

The Council are pleased to be able to say that the Local Government Board reversed their auditor's decision.

Building By-laws.

The Council have pleasure in reporting that the Local Government Board have in the main agreed with the suggestions made by the By-laws Committee for amendments to the Model Code of By-laws for Urban and Rural Districts. At the request of the Local Government Board the Committee attended at their offices, and were given an opportunity of laying their views fully before the various heads of departments. Evidence was given before the House of Lords Committee, on behalf of the Association, against certain clauses of the Public Health Acts Amendment Bill. The Committee are still engaged in watching the progress of various By-law Bills that are receiving the attention of both of the Houses of Parliament.

Visitors to the Meetings.

The question of the desirability or otherwise of unrestricted admission of visitors to the meetings of the Association has received the attention of your Council, and it has been found necessary to place the sole power of the invitation of visitors in the hands of the President.

Motor-Car Commission.

The Council appointed a committee to report as to evidence being given before this Commission. Upon their report it was not found desirable to tender evidence on behalf of this Association.

Legal Protection to Members.

The interests of the Member referred to in the last report are still being safeguarded by your Council.

National Association of Local Government Officers and Superannuation.

Mr. W. N. Blair is acting as the representative of the Council to this important organisation. It is hoped that the efforts to obtain superannuation will, sooner or later, meet with suc-

cess, despite the many serious obstacles which have to be overcome. The Council desire to recognise the value of Mr. Blair's work in this matter.

Registration of Plumbers.

The Worshipful Company of Plumbers have asked for the co-operation of your Association by the appointment of Members, in various districts throughout the country, who would be prepared to serve on committees of investigation. Your Council, having in mind the importance of good plumbing work in the interests of the public health, have appointed such representatives.

Secret Commission.

The attention of the Council has been drawn to a communication issued by a Constructional Company offering, to Members holding public appointments, commission on orders obtained.

A letter expressing the strong disapproval of your Council has been addressed to the company.

Conference on Smoke Abatement.

Your Honorary Secretary, Mr. Charles Jones, represented the Association at this Conference, which was held at Westminster, under the auspices of the Royal Sanitary Institute.

Joint Committee on Reinforced Concrete.

At the invitation of the Royal Institute of British Architects, your Council have appointed Mr. A. E. Collins and Mr. J. W. Cockrill to serve on this Committee.

Sanitary Institute Congress.

Mr. T. H. Yabbicom, Past President, and Mr. R. Read, are your representatives at this Congress, to be held at Bristol in July 1906.

International Engineering Exhibition, 1906.

Your President and Secretary represent the Association in connection with this Exhibition.

Result of Sale of Volumes I.–XX. at Reduced Price.

Members have taken considerable advantage of the opportunity given to them to complete their sets of "Proceedings" at the reduced price of 5*s.* a volume.

Appointment of Scrutineers.

To obviate the difficulty which arises when a scrutineer elected at an Annual Meeting is subsequently nominated for election on the Council, the Members are recommended to appoint eight scrutineers, and to empower the President to select as many as may be required for the purposes of the scrutiny.

Charles Jones, *Hon. Sec.*
Thomas Cole, *Secretary.*

On the motion of the President, seconded by Mr. C. Jones, the Report was received and adopted.

The President moved, and Mr. A. D. Greatorex seconded, that By-law 5A be altered to read as follows:—

5A. Any Member or Associate ceasing to hold a permanent appointment or position of the nature described in By-laws 2 and 2A as the case may be, shall cease to belong to the Association, but may be re-elected *annually in April* by the Council. No member so re-elected shall be a Member of the Council or hold any office in the Association other than that of Hon. Secretary or Hon. Treasurer.

After discussion it was decided to refer the matter back to the Council for reconsideration.

The Association's Premiums were then presented: 5*l.* in books to Mr. P. H. Palmer for his paper on "Armoured or Reinforced Concrete," 5*l.* in books to Mr. A. R. Galbraith for his

paper on "Reinforced Concrete Piling," and 3*l*. in books to Mr. J. Owen for his paper on "Tramway Materials and Construction."

Mr. W. Jones, of Colwyn Bay, was elected Hon. Secretary for the North Wales District, and the other District Secretaries were re-elected pending meetings in their various districts.

Mr. R. A. MacBrair and Mr. S. Stallard were re-elected Auditors for the ensuing year.

Messrs. R. J. Angell, A. H. Campbell, A. Gladwell, F. Harris, W. F. Loveday, H. Shaw, C. C. Smith, and O. E. Winter, were elected Scrutineers for the ensuing year.

Mr. Collins then introduced his successor, Mr. J. Patten Barber, and vacated the chair in his favour.

Mr. T. H. Yabbicom proposed a hearty vote of thanks to the retiring President for his services to the Association during the past year. This was seconded by Mr. W. Harpur, and carried with acclamation.

Mr. Collins acknowledged the vote.

Mr. Barber then read his Inaugural Address,* a hearty vote of thanks for which was proposed by Mr. A. D. Greatorex, seconded by Mr. C. H. Cooper.

The following papers were read and discussed: "Sewage Treatment in relation to Sewage Disposal," by J. D. Watson; "Sewage Disposal with Special Reference to Improvements in Primary Contact Beds," by W. J. Dibdin; "Motor Vehicles for Municipal Work," by J. A. Brodie; "Notes on the carrying out

* This Address and the papers read at the Meeting will be found at the end of the volume.

of Public Works Departmentally," by A. H. Campbell; "Road Construction, Maintenance, Improvements, and Subsidies," by H. T. Wakelam.

A vote of thanks to the President and Council of the Institution of Mechanical Engineers for the use of their Hall and rooms for the purposes of the meeting was carried unanimously.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.	£	s.	d.
To Balance, May 1, 1905	83	15	6
„ Balance of Petty Cash in hands of Secretary, May 1, 1905	2	9	3
„ Entrance Fees of Members and Associates	26	5	0
„ Subscriptions	919	10	0
„ Subscriptions in advance	29	15	6
„ Arrears	59	15	6
„ Sale of 'Proceedings'	48	1	8
„ Examination Fees	376	9	0
„ Interest on Investments..	44	4	11
„ Sundries		17	11
„ Redemption of Southampton Stock	200	0	0
„ Balance of Petty Cash due to Secretary, May 1, 1906	1	12	3
£	1792	16	6

Dr. STATEMENT OF ASSETS

LIABILITIES.	£	s.	d.
To Estimated Liability on Vol. XXXII.	40	0	0
„ Sundry Printing	10	0	0
„ Sundry Creditors	15	0	0
„ Balance of Petty Cash due to Secretary	1	12	3
„ Balance	1285	19	9
£	1352	12	0

Examined with the vouchers and

'OR THE YEAR ENDING APRIL 30, 1906. **Cr.**

EXPENDITURE.	£ s. d.	£ s. d.
By Reports of Meetings	..	29 8 0
„ Examiners' Fees and Expenses	..	252 4 4
„ Messrs. Clowes, for Vol. XXXI..	300 11 0	506 5 2
„ „ „ General Printing and Postages ..	205 14 2	
„ Auditors' Expenses	..	2 9 0
„ Meetings, Expenses	..	36 19 9
„ Stationery	..	17 5 0
„ Illustrations for Volume	..	57 2 0
„ Rent of Office and Coals	..	78 8 8
„ Bankers' Charges	..	16 5
„ By-law Committee Expenses	..	117 16 10
„ Typewriter, Furniture and Sundries	..	43 18 5
„ Return of Subscription	..	1 1 0
„ Rent of Telephone	..	7 10 0
„ N A.L.G.O. Subscription and Expenses of Delegate	..	11 4 0
„ Premiums	..	15 0 10
„ Messrs. Waterlow. for Certificates	..	92 15 9
„ Subscription to Times Law Report and Press Cutting Agency	..	6 10 0
„ Secretary, Salary	..	281 5 0
„ Assistant Secretary, Salary	..	118 13 4
„ Postage of Volume XXX.	..	29 15 7
„ Petty Cash—		
Postages	33 12 11	
General	20 8 7	
		54 1 6
„ Balance, May 1, 1906	..	32 5 11
	£	1792 16 6

ND LIABILITIES. **Cr.**

ASSETS.	£ s. d.	£ s. d.
By Balance at Bank, May 1, 1906	..	32 5 11
„ £290 Southampton Corporation 3½ % Stock at 100 ..	..	290 0 0
„ £553 12s. 9d. India 2½ % Stock at 80	..	442 18 2
„ £261 14s. 7d. London County Council 2½ % Consols at 76	..	198 18 2
„ £200 Metropolitan 2½ % Consolidated Stock at 79 ..	..	158 0 0
„ Loan to San. Insp. Joint Exam. Board	..	15 0 0
„ Subscriptions in Arrear	120 0 6	
Less 50 % bad	60 0 3	
		60 0 3
„ 'Proceedings' in Stock..	223 14 0	
Less 75 %	167 15 6	
		55 18 6
„ Office Furniture	..	99 11 0
	£	1352 12 0

and correct, *May* 23, 1906.

SIDNEY STALLARD } *Auditors.*
R. A. MACBRAIR }

LEWIS ANGELL, *Hon. Treasurer.*
CHARLES JONES, *Hon. Secretary.*
THOMAS COLE, *Secretary.*

SOUTH WALES DISTRICT MEETING.

July 14 and 15, 1905.

Held in the Council Chamber, Guildhall, Swansea.

A. E. Collins, M. Inst. C.E., President, *in the Chair.*

The Mayor (Alderman W. H. Spring) received the Members and offered them a hearty welcome to Swansea.

The President, on behalf of the Association, thanked the Mayor for the kind welcome he had given them.

Mr. W. E. C. Thomas was unanimously re-elected Hon. Secretary for the South Wales District.

SOME MUNICIPAL WORKS IN SWANSEA.

By GEORGE BELL, A.M.Inst. C.E., Borough Surveyor.

Swansea is a very ancient borough, which has long been prominent in the history of Wales, as shown by its charters, dating from the reign of King John. The Castle, which is the oldest remaining link with the past, was built towards the close of the eleventh century by Henry Beauchamp, Earl of Warwick, and, after being destroyed early in the thirteenth century, was rebuilt in the fourteenth by Henry De Gower, Bishop of St. Davids. A considerable part of this old structure remains, and its open parapet of Gothic arches is worthy of examination and

study. The Castle now forms part of the extensive property owned in the neighbourhood by His Grace the Duke of Beaufort.

The town is picturesquely situated at the mouth of the river Tawe, on the shores of one of the finest bays in the kingdom, from which the ground rises in a gradually increasing slope to a height of 570 ft. above the sea level. The configuration of the whole of the borough is of a very hilly and diversified nature, which, although presenting many features of natural beauty, makes the carrying out of most of the municipal works which have to be undertaken, more difficult and costly than would be the case in a flatter district.

For a very long time Swansea has been resorted to as a watering place, and during recent years it has been steadily increasing in favour, and in the summer time the sands and some of the parks are crowded with visitors from all parts of the country.

In addition to the natural attractions of Swansea itself, the town is fortunately placed by its proximity to the peninsula of Gower, which has a coastline made up of a succession of beautiful bays, extending for a distance of 20 miles from Swansea Bay to Worms Head, and the country adjoining is of the most delightful character, and full of interest and attraction for the artist, the antiquarian, and the health seeker. The land of Gower retains in a remarkable degree its old-world character, which is one of its greatest charms to the visitor, there being no railways and very little development of any kind. Anyone approaching Swansea on its eastern side, and getting a first impression from the numerous works and slag-tips on the banks of the Tawe, will find it difficult to realise the beauties lying to the westward of the town.

The geological formation on which the town stands is part of the great coalfield of South Wales, the dip of the measures being generally very steep and in a northerly direction. The coal worked within the borough is highly bituminous, and the native sandstone is very good, and is largely worked and used for building operations of all kinds.

Swansea is at the present day, and has been for many years, the chief seat of the copper, spelter, and tin-plate trades, and may claim to be one of the most important and progressive centres of commercial and manufacturing business in the United Kingdom.

The development of the port under the Harbour Trustees has kept pace with all requirements, the present wet dock accommodation extending over an area of 58½ acres, as follows:—

—	Acres.	Length of Quays.	Depth of water on Sill.
		ft.	ft.
North Dock	14	5,500	32
South Dock	17	5,200	34
Prince of Wales Dock	27½	6,190	32

The construction of a new deep-water dock has been commenced to accommodate the largest class of steamships afloat, to deal with the increasing trade of the port—in which will figure more largely in the future, anthracite coal, which composes that part of the South Wales Coalfield adjacent to Swansea, and the natural outlet for the exportation of which is the port of Swansea. For this purpose it is intended to reclaim nearly 400 acres of land on the foreshore. The dock will have an area when completed of 107 acres, and the depth of water on the sill will be 40 feet at H.W.O.S.T., and the estimated cost with equipment is 1,250,000*l.* The first sod for this dock was cut by H.M. the King in July last year, and the dock is to be called "The King's Dock." The joint engineers are Mr. P. W. Meik, M.Inst.C.E., and Mr. A. O. Schenk, M.Inst.C.E., and Messrs. Topham, Jones, and Railton are the contractors.

A new plate girder draw-bridge has just been completed by the Harbour Trustees over the North Dock Lock, which was necessary for the largely-increasing traffic between the east and west sides of the river. This bridge has a double line of roadway, on which tramways are laid, two footpaths, and a line of railway, and displaces an old swing-bridge which had only a single line of roadway, footpath, and railway. Over the river Tawe, on the main road from east to west, a new lattice-girder swing-bridge was erected by the Harbour Trustees in 1897, and has the same accommodation as the new drawbridge. Both these bridges were designed by Mr. A. O. Schenk, M.Inst.C.E., the engineer to the Harbour Trustees, and constructed by Messrs. Handyside, of Derby, and are well worthy of inspection, especially to municipal engineers, in connection with the tramway construction over the same.

General Statistics.

The area of the Borough above high-water mark is 5070 acres, and the population at the census of 1901 was 94,514, and it is now estimated at 100,000. The number of houses is 19,487, giving an average number of 5·13 persons per house. The death-rate from the last annual report of Dr. Eben Davies, the Medical Officer of Health, was 17·6 per thousand, including 2·17 per thousand for the seven zymotic diseases. The present rateable value of the borough (for poor rate purposes) is 447,718*l.*, and the outstanding debt for sanitary purposes only is 703,000*l.* The general district rate amounts to 4*s.* 4*d.* in the pound, and the poor rate, including the borough rate, is also 4*s.* 4*d.* in the pound.

Public Roads and Streets.

The length of public roads and streets is 79 miles, 6¼ miles being main roads taken over in 1889 and 1891, and in respect of which a contribution is made from the National Exchequer, covering the cost of maintenance.

Excepting the Strand, having a length of nearly 1 mile, granite-paved in 1894 at a cost of 8343*l.*, and some of the tramway routes described later, the whole of the public highways are macadamised.

The material used at present is syenite from Port Nant, in North Wales, carboniferous limestone from Mumbles, millstone grit, obtained from pebbles excavated from building sites in the town, native sandstone, and copper works slag, used according to the degree of importance of each particular street or road. The prices for the current year for the broken stone 2-inch gauge are as follows: syenite, 7*s.* 3*d.* per ton alongside Corporation Wharf, or 7*s.* 9*d.* in depôt; limestone, 4*s.* 8*d.*, 5*s.* 2*d.*, and 5*s.* 9*d.* per ton, delivered on streets in the various town districts, or 4*s.* 1*d.* in truck at Landore or Morriston Stations; native sandstone from Cwmdu Quarries, Ynismeudw, 5*s.* 6*d.* per ton in truck at Swansea, Landore, or Morriston stations.

An analysis of the Port Nant stone by Mr. Norman Tate, of Liverpool, is as follows:—

Chemical Composition.

Silica	66·168
Alumina	19·881
Oxide of iron	8·920
Lime	2·120
Magnesia	1·442
Soda	0·210
Potash	0·838
Traces of manganese, loss, etc.	0·421
	100·000

Mineral Constituents.

Quartz	50
Hornblende	40
Felspar	10
	100

A description of the Cwmdu stone by Dr. Flitt, of London, is as follows:—

"This is a dark grey, speckled, impure sandstone, which consists of rounded quartz grains, fresh and weathered felspar, black pieces of shale or slate, fragments of quartzite, felsite, a little white mica, iron oxides, zircon, etc. The average diameter of the grains is about $\frac{1}{50}$ inch, the cementing material is silicious. The rock has the appearance and composition of a fresh and good sample of the well-renowned Pennant Grit of South Wales."

Neither of these stones have been used in Swansea sufficiently long enough for a proper opinion to be formed of their qualities. The great difficulty experienced in regard to the supply of road metal is as to the breaking, and although a strict specification is drawn up, tenders and samples obtained, and contracts entered into, it seems impossible to obtain at a moderate price with any degree of certainty what is required, viz.: metal broken to a regular gauge and shape, either by machine or hand; consequently cargoes have had to be rejected, or abatements made in the price, and some contracts terminated.

The Corporation have three 10-ton road rollers, two by Messrs. Aveling and Porter, and one by Messrs. Green, of Leeds. One of the former is fitted with a Morrison's scarifier and the latter with a Bomford scarifier, both of which work satisfactorily without causing any undue additional cost of upkeep to the rollers.

When the recoating of any road or street has been deter-

mined upon, formal notice is sent to the various departments and companies having underground works therein, informing them of the intention, and requesting that any prospective work may be carried out beforehand, ample time being allowed for the purpose.

In carrying out the recoating or repair, the scarifiers are used as far as possible for cutting up the old surface, and after new metal has been put on and rolled dry, binding material of native gravel or road grit is laid on and well watered and rolled, and afterwards a top dressing, preferably of fine Appledore gravel, which completes the filling up of the interstices between the road metal, and leaves a clean even surface without any tendency to stickiness, or licking up.

The work of recoating and repairing the roads is carefully watched and measured up, and a detailed statement of the cost is kept in the form appended herewith (see table, page 18), setting out particulars of the materials used, the labour, haulage, and rolling, and the time occupied in the work. The total cost per square yard of each coat is shown, and the statement has proved to be of much value for reference and comparison. As an index to these sheets, a map of the town is posted up during each year showing in colour the extent of each road repair, and the month is noted thereon, and from these maps may be seen at a glance the time each coat lasts.

The entries on the form referred to are fair average examples of actual recoatings for the year 1904–5, for each kind of material used.

The annual cost of the maintenance of every public road and street in the borough is also kept, with the cost per square yard of each, upon a tabulated statement (see table, page 19), which also shows the average cost for three and six years, the form of which is given herewith, with the costs of certain syenite and other roads.

A table which has been found useful in connection with this matter, showing readily the cost per mile of roadway of different widths at varying rates per square yard, is appended (page 21).

The total expenditure on the maintenance of the roads and streets for the year ended March 31 last amounted to 6402*l.*, equal to an average of 81*l.* per mile.

The Corporation have two principal depots for street works, viz. at East Burrows Wharf, having a water frontage to the

AVERAGE EXAMPLES OF THE COST OF REPAIRING MACADAMISED ROADS IN SWANSEA.

Note.—The item for rolling includes drivers' wages, fuel, oil and waste, and repairs and depreciation only, and is taken at the rate of 20s. per day.

Name of Street or Road.	Duration of Work.		Stone Used.						Gravel or Chippings Used.				Cost.					
	Commenced.	Completed.	Kind.	Quantity.	Price.	Amount.	Area covered	Sq. yds to 1 ton	Kind.	Quantity.	Price.	Amount.	Total Materials.	Labour.	Haulage.	Rolling.	Total.	Per Sq. Yd.
				tons. cwt.		£ s. d.	sq. yds.			T. c. qr.		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.
								SYENITE ROAD.										
	1904.																	
Dyvatty Street	May 28	June 1	Arklow	27 12	8/2	11 5 6	436	15·8	Appledore	6 2 0	4/6	1 7 5	12 12 11	2 6 0	2 11 10	2 10 0	20 0 9	11
								LIMESTONE ROAD.										
Fynone Road	April 27	May 9	Mumbles	71 14	5/9	20 12 3	1291	18	Limestone	12 18 1	5/9	3 14 3	24 6 6	5 13 1	0 15 0	5 0 0	35 14 7	6·6
								MILLSTONE GRIT ROAD.										
Ebenezer Street	May 27	May 29	Broken pebbles	17 cu. yds.	1/9	1 9 9	557	32·7	Appledore	5 14 2	4/6	1 5 9	2 15 6	2 10 9	0 17 1	2 15 0	8 18 4	3·8

AVERAGE EXAMPLES OF THE ANNUAL COST OF MAINTAINING MACADAMISED ROADS IN SWANSEA.

Name of Street or Road.	Length in Yards.	Average Width in Yards.	Area in Yards.	Situation.	1897-98. Cost for Year.	1898-99. Cost for Year.	1899-1900. Cost for Year.	Average Cost per annum for past 3 years.	Average Annual Cost per sq. yard for 3 years.	1900-1. Cost for Year.	1901-2. Cost for Year.	1902-3. Cost for Year.	Average Cost per annum for past 3 years.	Average Annual Cost per sq. yard for 3 years.	Average Cost for past 6 years.	Average Annual Cost per sq. yard for 6 years.
					£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	d.	£ s. d.	d.
SYENITE ROAD.																
Oxford St.	550	8	4400	Dillwyn St. to Goat St.	32 12 1	171 13 8	150 5 6	118 3 9	6·44	48 4 5	145 8 3	95 14 11	96 9 2	5·26	107 6 5	5·85
LIMESTONE ROAD.																
Henrietta St.	240	8	1920	Walter Rd. to St. Helen's Rd.	35 8 8	24 13 0	—	20 0 7	2·50	28 12 7	15 15 0	1 17 9	15 8 5	1·93	17 14 6	2·21
MILLSTONE GRIT ROAD.																
Matthew St.	193	7	1351	Dyvatty St. to High St.	—	6 16 0	11 9 5	6 1 10	1·08	—	—	—	—	—	3 0 11	0·54

harbour of 95 yards, where a certain quantity of road metal is discharged and stored, and the other close to, in Cambrian Place, with storekeeper's office, weighing machine, masons' sheds, water van sheds, and general stores.

The rates of pay of the roadmen are as follows:—

General foreman	41s. per week.
District foreman	30s. "
Leading roadmen	26s. "
General roadmen	22s. to 24s. "

The public footpaths are paved with Irish and native flags, and approved artificial stone is allowed to be used in private streets.

Tar macadam made with limestone has been used to some extent in Somerset Place, adjoining the Guildhall, in some back roads and passages, and for many street crossings. It is found to be generally satisfactory, and, although its first cost is greater than ordinary macadam, it lasts longer under light traffic and requires less cleansing. The mixture used is in the proportion of 12 gallons of tar to 30 lb. of pitch, boiled in a tar boiler, and added to dry stone of three grades, viz. 2 inch, 1 inch, and ½ inch respectively. Formerly the stone was heated and dried by being covered over in long beds with coke breeze, and fires lighted on the top, but it was found that the stone generally became too hot, often being burnt into lime, and in mixing a considerable portion of the tar was evaporated and wasted. Perfectly satisfactory results are now obtained without heating the stone. In laying the material down in a roadway each layer is separately rolled with a steam roller, and the whole is covered over with a top dressing of fine gravel or fine limestone chippings and dust. The street crossings, which are only laid in places where no provision is made for paved crossings, are treated in a similar manner when made at the same time as the remainder of the street, but, when otherwise, the material is consolidated by means of iron rammers.

The cost of the tar macadam laid complete averages 2*s.* 3*d.* per square yard.

New Buildings and Streets.

The following statement gives the number of plans passed for new buildings and streets for the past 10½ years, from which it will be seen that from 1896 to 1900 the total number steadily

COST PER MILE AT VARYING RATES PER SQUARE YARD AND DIFFERENT WIDTHS.

Per Square Yard.	Yards in Width.																										
	4			5			6			7			8			9			10			11			12		
Pence.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1	29	6	8	36	13	4	44	0	0	51	6	8	58	13	4	66	0	0	73	6	8	80	13	4	88	0	0
2	58	13	4	73	6	8	88	0	0	102	13	4	117	6	8	132	0	0	146	13	4	161	6	8	176	0	0
3	88	0	0	110	0	0	132	0	0	154	0	0	176	0	0	198	0	0	220	0	0	242	0	0	264	0	0
4	117	6	8	146	13	4	176	0	0	205	6	8	234	13	4	264	0	0	293	6	8	322	13	4	352	0	0
5	146	13	4	183	6	8	220	0	0	256	13	4	293	6	8	330	0	0	366	13	4	403	6	8	440	0	0
6	176	0	0	220	0	0	264	0	0	308	0	0	352	0	0	396	0	0	440	0	0	484	0	0	528	0	0
7	205	6	8	256	13	4	308	0	0	359	6	8	410	13	4	462	0	0	513	6	8	564	13	4	616	0	0
8	234	13	4	293	6	8	352	0	0	410	13	4	469	6	8	528	0	0	586	13	4	645	6	8	704	0	0
9	264	0	0	330	0	0	396	0	0	462	0	0	528	0	0	594	0	0	660	0	0	726	0	0	792	0	0

declined, which is accounted for by the fact that owing to the number of houses built about the year 1895 the supply exceeded the demand, and that since 1900 the necessity for more houses has again shown itself, and building has been proceeding rapidly. At the present time there is a considerable scarcity of houses, but this appears likely to be soon overtaken, as shown by the largely increased number of plans passed during this year to date.

Year.	New Streets.	New Houses and Shops.	Places of Worship.	Schools.	Other Buildings.	Totals.
1895	13	345	4	..	89	451
1896	2	342	3	2	111	460
1897	4	136	7	3	100	250
1898	3	81	3	1	90	178
1899	6	69	..	2	97	174
1900	..	45	1	..	76	122
1901	..	89	2	..	82	173
1902	2	162	2	..	121	287
1903	1	203	3	5	102	314
1904	1	175	8	6	86	276
Average for 10 years . ..	3	164	3	2	95	268
To date, 1905	8	282	2	3	69	364

Street Lighting.

The streets are principally lighted by gas, supplied by the Swansea Gas Light Company at 2*s.* 8*d.* per 1000 cubic feet.

At the end of March last there were 1724 ordinary flat flame gas lamps, burning 4 cubic feet per hour, costing for gas 1*l.* 17*s.* 1*d.*, and for maintenance, repairs, cleaning, lighting, and extinguishing 18*s.*, equal to 2*l.* 15*s.* 1*d.* per annum; 89 ordinary incandescent gas lamps, burning 4 cubic feet per hour, with an additional charge of 8*s.* per annum for maintenance of mantles, equal to 3*l.* 3*s.* 1*d.*; 92 incandescent gas lamps, burning 4½ cubic feet per hour, and costing 3*l.* 13*s.* 5*d.* per annum.

The pillars, lanterns, and cradles are supplied and renewed

by the Corporation, ordinary pillars costing 27*s*. each, ordinary lanterns 11*s*. 9*d*. each.

The number of hours of burning per annum is 3472½.

Of electric lamps supplied by the Corporation Electricity Department, there are 54, 12½-ampere arc lamps in the main streets in the centre of the town, charged at 25*l*. each per annum; 9, 8-ampere arcs in St. Helen's Road at 11*l*. each; 32, ½-ampere Nernst lamps, charged at the same price as ordinary incandescent gas lamps; and 27, ¼-ampere Nernst lamps, charged at the same price as the ordinary flat flame gas lamps.

The Council have under consideration the extension of electric lighting to the roads and streets through which the new light railways and tramways have been laid.

Private Street Works.

A large amount of private street work has been dealt with, especially during the last five years; during which period plans, estimates, and apportionments have been prepared for 49 streets. The work in 36 of these streets, having a total length of 3 miles, has been executed by the Corporation at a cost of 7250*l*., which amount is recovered from the frontagers. As to the remainder of the streets, the work has either been carried out entirely or partly by the frontagers, or is waiting for notices or decisions thereon.

The proceedings are taken under the Swansea Corporation Act, 1889, which is the same as the Private Street Works Act, 1892.

After the plans, etc., have been prepared, and notices served, the frontagers are allowed, if they so desire, to carry out, under proper supervision, as much of the work as they can deal with individually in front of their respective premises; and although there are advantages in this method on account of the lesser amounts to be collected by the Corporation, the result of doing the work piecemeal is not always satisfactory.

Street Improvements.

As opportunities have occurred in connection with the expiration of leases, and the rebuilding of premises, the Corporation have since 1892 expended 12,585*l*. in purchasing property and

carrying out the widening of various roads and streets in the town.

The widening of Castle Bailey Street was carried out in 1889, by agreement, at a cost to the town of 16,000*l.*

In connection with the widening of Castle Street, which has long been a much-needed improvement in the centre of the town, property costing 114,122*l.* has been acquired by agreement since 1895, and there now only remain five premises to be purchased —which will be dealt with compulsorily under the Corporation Act of 1902. Castle Street has a length of 400 feet, and at several points is only 18 feet wide. It is intended to widen the street to 50 feet, which will give a wide main artery extending from the Great Western Railway Station in High Street to the bottom of Wind Street, and enable the connecting link of the tramways between High Street and Castle Bailey Street to be carried out according to the Light Railways Order, 1902.

Cleansing, Etc.

Down to 1892, the work of removing ashes and house refuse, and also the street cleansing, was being carried out under contracts, but as it was very unsatisfactory, the Council in May 1892 decided to do the work themselves, and premises on the Strand belonging to the Corporation were selected as a site for the stables, etc. The old works and buildings which stood upon the site were partly pulled down, and new stable buildings to accommodate 24 horses, and also a house for a resident horsekeeper, erected at a cost of 2200*l.*, for which a loan was obtained for a period of 30 years. Horses, carts, harness, and the necessary plant were purchased at a cost of 2394*l.*, for which the loan was repayable in 5 years. Since that time old buildings on the same site have been altered to accommodate a further 16 horses, the cost, 284*l.*, having been paid out of revenue.

The present stud is 40 horses, and the plant consists of four 3 yard and twenty-two 2½ yard wagons, eight 1½ yard carts, twenty 1 yard stone carts, one horse sweeper and two drums.

Renewals of horses, carts, wagons, and harness have been made out of revenue during the past 11 years, and the amount expended has been: horses, 3103*l.*; carts and wagons, 822*l.*; harness, 132*l.*; or an average for—horses, 282*l.*; carts, 103*l.*; harness, 26*l.*; per annum.

For the year ended March 31 last the expenditure was:—

	£
Wages	6,454
Keep of horses	1,447
Horse hire	1,402
Repairs to carts and wagons	351
Veterinary surgeon	50
Shoeing	127
Rent and rates	181
Electric light, power, coal, etc.	49
Harness repairs and stable requisites	105
Purchase of horses and wagons	233
Brushes, pans, tools, sundries, and all other charges	305
	10,704
Interest and sinking fund on buildings	114
	10,818
Less credit for work done for haulage of stone, etc. ..	2,916
Net cost per annum	7,902

The quantity of house and trade refuse and street sweepings collected for the year referred to amounted to 47,768 loads, and works out at a cost of 3*s.* 4¾*d.* per load. The cost of keep of horses (fodder and bedding only) averaged 13*s.* 0½*d.* per horse per week, as against an average of the past 12 years of 12*s.* 9*d.* per horse per week.

The staff comprises: 1 superintendent, 1 foreman at 35*s.* per week, 1 resident horsekeeper at 30*s.*, 1 assistant horsekeeper at 25*s.*, 1 clerk at 24*s.*, 39 drivers at 24*s.* to 25*s.*, 35 carriers at 23*s.* to 30*s.*, 17 sweepers at 20*s.* to 24*s.*, 3 tipmen at 18*s.* to 25*s.*, 1 orderly at 18*s.*

The system of collection of ashes, house and trade refuse, in operation is, as far as circumstances permit, from receptacles placed outside by the occupiers of premises at notified hours and days, a large number being every day and others on alternate days, and the remainder from ashpits, which are cleared once or twice a fortnight, as required.

The cleansing of the main thoroughfares is done daily from midnight to 5.30 a.m. the following morning, and collected from 6.30 to 7.30 a.m. The other roads and streets are cleansed according to importance and locality, some once and some twice a week. Sunday work is from 2 a.m. to 8 a.m. on the main streets only.

All haulage work required by the different departments is

arranged for by the superintendent, upon receiving overnight a requisition stating the number of loads and the places to and from which the material has to be hauled, the charge for which is by agreed tonnage schedule where the material is weighed, or otherwise at 1*s.* per hour. On account of the scattered and hilly nature of the borough a larger number of horses is required than would be the case in a more compact and less hilly district, and this necessitates either the keeping up of a very large stud, or the hiring of a certain number of horses. The horse hire for the past 5 years has averaged over 750*l.* per annum, being at the rate of 8*s.* 6*d.* per day for horse, cart, and man. The Council have considered the advisability of erecting additional stables at Morriston, a distance of 3 miles from the present stables, but have not yet come to a decision.

The daily average of horses employed for the past year was: on scavenging work 28·33, and for general haulage 24·07, equal to 52·40 per day. Of this number, 37·08 were Corporation horses and 15·32 hired horses.

The plant for watering streets comprises one "Willacy" patent rotary van, nine 4-wheel 400-gallon, two 350-gallon vans, and six 200-gallon carts; and two additional patent rotary vans of 350-gallons each are now being made by Messrs. Glover and Son, of Warwick.

Watering was done on 99 days of last year, and the amount expended was 587*l.*, including repairs of vans, and 159*l.* charged for water from mains. The total quantity of water used was 19,287 loads.

Destructor.

Owing to the increasing difficulties of obtaining suitable places for tipping the town refuse without causing present or future nuisance or danger to the public health, the Corporation decided upon establishing a destructor; and a sub-committee, with the Author, visited a number of places where such works are in operation, and obtained a considerable amount of information relating to the same.

A number of sites were considered, and at length one was fixed upon on vacant land in hand belonging to the Corporation, between Llangyfelach Road and Cwm Road, within a distance of ¾ mile from the centre of the town, and at a level of 120 feet above O.D., which is a medium level as regards the districts

to be served. The gradients leading to the site are very satisfactory, especially as compared with those leading to the former tipping place for the town districts, at Waun Wen Quarry, which is 1¼ miles from the centre of the town, and 210 feet above O.D., and the present available tipping-place on vacant ground situated at Gorse Road, at a distance of 2 miles from the centre of the town, and 300 feet above O.D., at both of which places chain horses have to be employed.

The configuration of the site selected was very suitable for the construction of the works, no inclined approach road being required, as the necessary depth for the cells is obtained in the slope of the ground, and the clinker can be disposed of for a considerable time in filling up ground adjoining, and in the construction of the works for culverting and covering over the Burlais Brook, and the widening of Cwm Road in the valley close alongside the site.

The area of the site occupied by the destructor and works connected therewith is ¾ acre, and a rental of 30*l.* per annum is credited to the Corporation estate for the same.

Designs and tenders were invited for the plant and buildings, and those of the Horsfall Company accepted at 9591*l.* The Corporation undertook the excavation of the ground (excepting for the foundations of the chimney stack), the drainage and water supply. The total cost of the whole of the work, including some extras, will amount to 11,215*l.* The Local Government Board sanctioned a loan of 10,500*l.* for the works, repayable in 22 years, and application for the additional sanction required is now being made.

The destructor has five cells, of the back-feed type, each having a grate area of 42 square feet (7 feet by 6 feet), fitted with steam jets for forced draught. The chimney is circular, 120 feet high above ground level, and 5 feet internal diameter. The foundations for the same were carried down a depth of 21½ feet to a solid bottom of strong gravel and clay, upon which a block of cement concrete 24 feet square and 10 feet thick was laid to carry the stack. A Lancashire boiler 30 feet long and 8 feet 6 inches diameter is provided at the back of the cells under the feeding bin, and through which the hot gases from the burning of the refuse pass. An independent coal firing furnace 7 feet by 6 feet is provided at the end of the boiler for use in lighting up after cleaning, or at such times as refuse is not available.

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The destructor house is 68 feet long by 46½ feet wide, over all, and 22½ feet high to the square of the roof from the level of the lower yard, substantially built of native sandstone rubble, and is covered with an iron and slated roof. In a separate building (42 feet by 28½ feet), at a distance of 42 feet from the destructor house, is installed machinery for dealing with the clinker, viz., engine of self-contained vertical type having 9-inch cylinder and 12-inch stroke, supplied with steam from the destructor boiler; clinker-crushing mill with elevator and screen for four grades, capable of crushing and screening about 4 tons of dry clinker per hour; mortar mill with 7-feet diameter pan, which can turn out about 8 tons of mortar per day.

The steam generated from the burning of the refuse is intended to be used chiefly for driving the electrical machinery for working portions of the tramways. This machinery is installed in a building placed at a distance of 40 ft. from the destructor house, and consists of engine room 40 ft. by 25 ft. by 25 ft. high to square of roof, office, store, etc., and attached to the same building are the weigh-office, mess-room, etc., in connection with the destructor.

The apportioned cost of the building for electrical machinery is 1235*l.*

The machinery is described by Mr. Prusmann, the borough electrical engineer, in his paper.

Drying fires were lighted in the destructor on the 4th of July, 1904, and refuse commenced to be burnt on the 27th of the same month. It is satisfactory to note that no nuisance from smell, smoke, or dust, either from the stack or the cells, has been caused so far from the burning of the refuse.

The average quantity of refuse delivered and dealt with by the destructor since the time of working is 52 tons 14 cwt. per day, the largest quantity in one day being 80 tons 15 cwt., the contractors' guarantee being 64 tons.

The weight of residue produced has not yet been tested, but it is believed to be within the 33 per cent. guaranteed.

From tests made by the borough electrical engineer on the 21st and 23rd February last, the average quantity of water evaporated in the boiler from the burning of the refuse was equal to 7125 lb. per hour, reduced to 4453 lb. per hour by the jets for forced draught, the pump and the clinker engine, which at 20 lb. per I.H.P. would be equivalent to 222 I.H.P.

per hour available for use for electrical purposes at the stop valve of the boiler.

The steam pressure test, taken every 15 minutes over a period of 12 hours on the 21st of February, gave an average of 170 lb., the highest reading being 180 lb. and the lowest 158 lb.

From a 23 hours' test made on the 12th and 13th of January last, under the direction of the contractors, and verified by the works foreman, 70 tons 16 cwt. of refuse were burned, and an average of 6740 lb. of water evaporated per hour, equal to 1·20 lb. per lb. of refuse.

The flues have so far required to be thoroughly cleaned out at intervals of about 9 weeks, the work taking from 3 to 5 days. The largest deposit takes place in the exhaust flues, and at their junctions with the main flue, where the dust becomes fused and hardens in successive layers; but it is hoped that this will be obviated to a large extent by the insertion of small doors for cleaning as frequently as possible, so as to prevent the accumulation taking place.

The mortar made from the 4th of August, 1904, to 31st May, 1905, has amounted to 720 tons, and is used for all the purposes of the Corporation in the town, the price charged being 5*s.* per ton, which covers all the costs and charges in connection with the same. A quantity of the graded clinker has been used for making up roads and footpaths and as racking for granite paving, but is now being stored ready for making concrete for the Burlais Brook culverting, etc., afterwards referred to, and now about being commenced. This graded clinker has been regularly watered in the dry weather, as stacked, to ensure the thorough slaking of all calcareous matter produced by the burning of shells, bones, limestone, etc., before the clinker is required for use for concrete, which is an important point in connection with the use of this material for concrete.

A retaining wall of graded clinker concrete (6 to 1 of cement) was built at the destructor works last winter, when work was being found for a number of unemployed men. This wall is 36 feet long, 10 feet high, and averages 3 feet thick, and is a good example of the use that can be made of the clinker. It was erected by ordinary labourers, under the direction of the clerk of the works, but the cost was not kept separate from the excavation which was proceeding at the same time.

It was found that a cube yard of clinker and ashes as taken from the cells, weighed 12¼ cwt., and a cube yard of crushed clinker weighed 17 cwt.

A cube foot of clinker concrete as used in this wall, weighed 105 lb., whereas a cube foot of native stone concrete, as used in the bottom part of the chimney foundations, weighed 133 lb., and broken brick concrete used in the upper part of the same weighed 121 lb.

As the first year's working of the destructor has not been completed, the total quantity of refuse dealt with in one year cannot yet be stated, nor the cost per ton for all charges.

When the total annual cost is arrived at, credit must be taken for the saving in haulage to the destructor, instead of to the present available tip (estimated at 1*s.* 6*d.* per ton), and for the value of the steam produced from the burning of the refuse and supplied to the electrical machinery for tramway purposes, and the smaller amounts resulting from the making of mortar and the preparation of clinker. It is not anticipated that the debit balance, which will then be placed against this undertaking, will be more than is justified, having regard to the more sanitary method of disposing of the refuse.

The question of utilising the clinker for the manufacture of flags and bricks is under consideration by the Council, and tenders for the necessary plant have been obtained; but the matter is in abeyance for the present, or until it is ascertained how much, if any, steam can be spared for the purpose.

A trial is now being made at the destructor works, with clinker, of a hollow concrete block machine, manufactured by Messrs. Pettyjohn Brothers, of Terre Haute, Indiana. The machine is worked entirely by manual labour, and makes hollow blocks, 20 inches long, 7½ inches high, and 8 inches wide, as stretchers, and other sizes as halves, quarters, corners, etc. The face or faces of the blocks can be moulded rock faced, fine picked, or plain chamfered, as required. Specimens of the blocks made, and the operation of the machine, which is the first to be used in this country, can be inspected at the works. If the blocks turn out as stated, their manufacture would be the means of utilising a considerable portion of the clinker from the destructor, and may help forward the scheme which the Corporation have in hand for providing cheap and good dwellings for workmen, which are much required at the present time.

The question of barging the refuse which cannot be taken to the destructor, and the street sweepings, out to sea beyond a line 3 miles from the Mumbles Head, is now under consideration by the Council.

Absorption Test by Weight of Specimens of Fine Destructor Clinker Concrete and Other Materials.

July, 1905.

Each specimen, after being thoroughly dried in an oven, was weighed, and after immersion in water for twenty-four hours was again weighed, the difference giving the percentage of absorption, as follows :—

	Per cent.
Morriston pressed brick	2·45
Native (Swansea) stone	8·4
Fine Appledore gravel concrete, 3 to 1	9·0
Fine destructor clinker concrete, 4 to 1	9·2
Morriston wire cut brick	9·4

George Bell,
Borough Surveyor,
Swansea.

J. Bingham,
Inspector of Weights and Measures,
Swansea Corporation.

Intended Culverting of the Burlais Brook.

This work, which has been referred to in connection with the destructor, has been long contemplated by the Corporation as a very necessary sanitary improvement. The brook follows a very tortuous course for a length of about 600 yards between the Pentre and Aberdyberthi bridges respectively, above and below which it is culverted. It is a receptacle for refuse of all kinds, which causes not only a nuisance to the inhabitants of the houses alongside, especially when combined with condensing water from the various works, but considerable expense to the Corporation for periodical cleansing.

By the instructions of the Council, the Author prepared in 1890 a scheme for carrying out part of the work, and for utilising the sites which would be formed above and adjoining for building purposes, and application was made to the Local Government Board for power to borrow a sum of 4500*l*. for the purpose; but this application was not sanctioned, as the Board considered that the erection of the houses was of too speculative a character. In the Corporation Act of 1902 power has, however, since been obtained to carry out the work, together with

the widening of Cwm Road, at a cost of 7714*l*., repayable in 60 years.

The utilisation of the destructor clinker would be an advantage to this work, as well as to the destructor undertaking.

The culvert would be 6 feet high by 6 feet wide, with segmental invert and semi-circular arch, and together with the retaining wall alongside would be formed of clinker concrete in proportions of 6 to 1 of cement, the invert and sides of the culvert being lined with blue brick in cement. The gradient of the culvert would be 1 in 45, which is of course very steep for a large body of water, and on this account the cross-section shown was adopted in order to minimise the velocity as much as possible, and blue brick lining to the invert and sides provided to withstand the scour and the acids in the water.

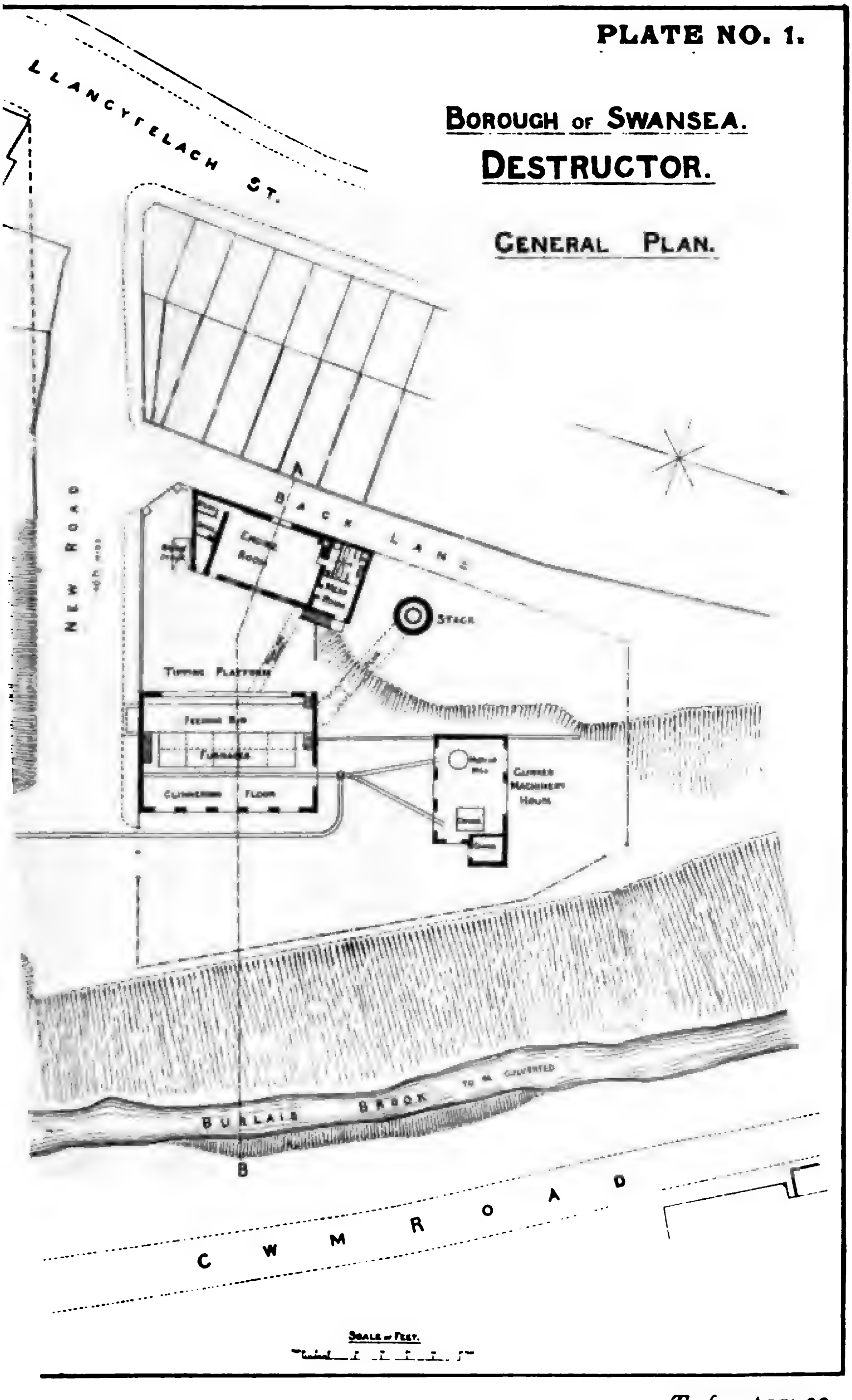
Corporation Smithy and Wheelwrights' Shop.

In October 1904 a smiths' and wheelwrights' shop was established, in order that the smiths' work, then being done in different yards and under different departments, might be better organised, and also to do the shoeing of the horses and the wheelwrights' work, instead of having to get the same done at different shops in the town.

A portion of a yard occupied by the waters and sewers department was taken, and alterations and additions made to an old building at a cost of 176*l*.; and 173*l*. was laid out in the purchase of 3 Alldays and Onion's iron smiths' hearths, 1 Maud and Turner's drill, 1 "special" bandsaw, tyre bender, wheel plate, and other necessary appliances.

The fires are blown by means of a "Sydenham" revolving fan, driven by a 5 H.P. electric motor, which also drives the drill and bandsaw.

The charges for work done are based on prime cost for labour and materials used, with an addition of 20 per cent. to cover working expenses. Allowing 10 per cent. on the outlay for alterations, plant, tools, and fittings (which was paid for out of revenue), and 10 per cent. depreciation on plant, the addition of 20 per cent. gives a surplus of nearly 4 per cent. The work done is very satisfactory, experienced men being employed, and the best materials used. The staff comprises: 1 foreman smith 2 smiths, 3 strikers, and 2 wheelwrights.



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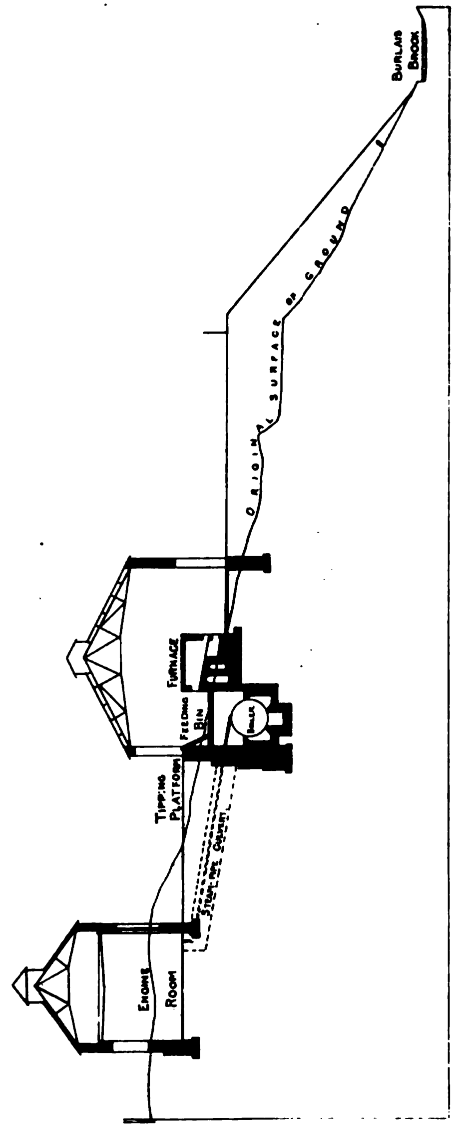
BOROUGH OF SWANSEA.

DESTRUCTOR.



SECTION A-B.

SCALE OF FEET.

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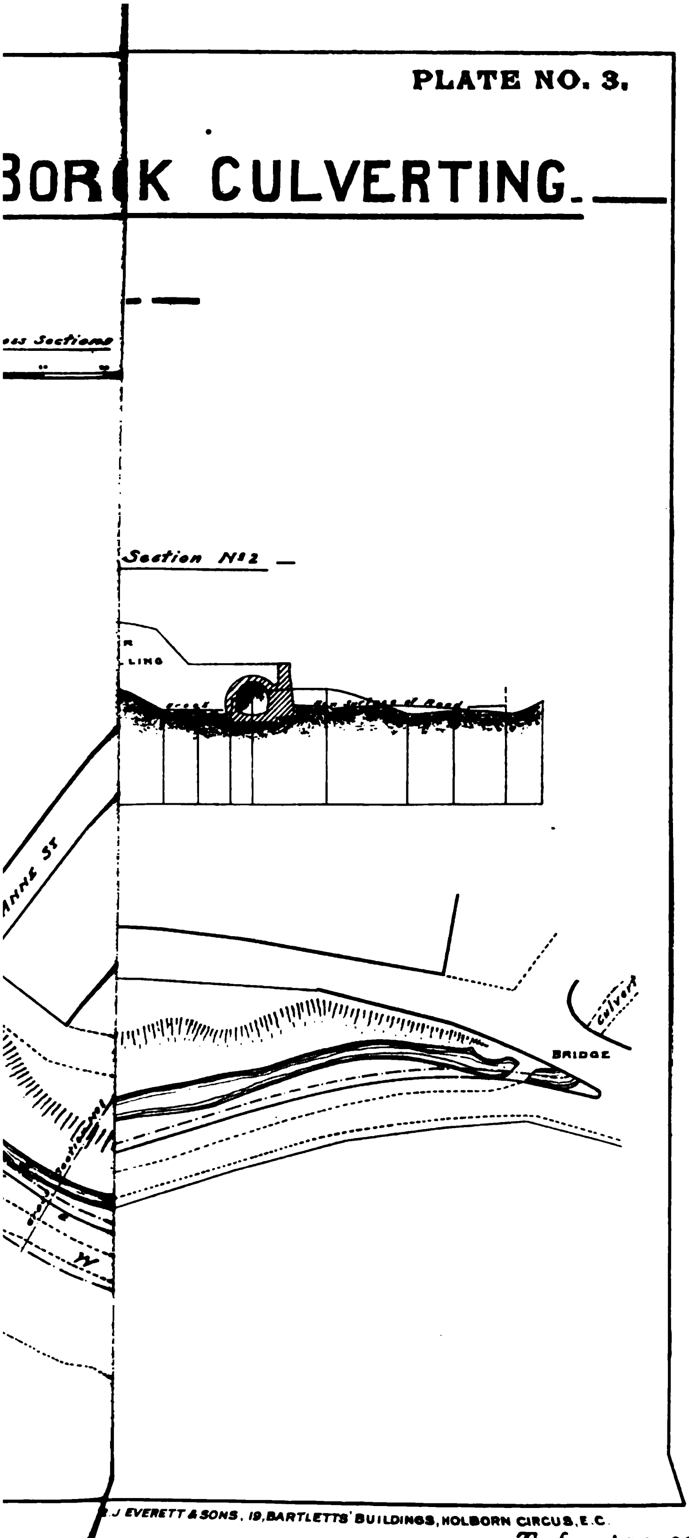

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Two large wagons, capable of holding 3 cubic yards, have been built at the shop, the first costing 42*l.* 5*s.* 6*d.*, and the second 36*l.* 18*s.* 4*d.*

Special attention is given to the shoeing of the Corporation horses, for which a charge of 4*s.* 6*d.* per set is made—the same price as formerly paid to contractors—and the shoeing work at this price has shown a surplus of 5½ per cent.

Cwm Gelli Cemetery.

The necessity for additional burial ground for the north-western portion of the borough was pressed upon the Corporation in consequence of the filling up of the existing burial grounds, used in connection with the various churches and chapels in the neighbourhood, and the distance to the general cemetery about 3 miles.

After considering several sites, the Corporation fixed upon one on the hillside at Cwm Gelli, and 19 acres of land, including 6 cottages, were acquired in January 1893 at the moderate price of 80*l.* per acre. It was decided that the southern portion, containing 8½ acres, should be used for present purposes, and the remainder retained for future extension. This did not appear to be an ideal site for a cemetery, as it was very irregular in shape, and sloped considerably, the extreme difference of level being 72 feet, besides which there was an abandoned colliery shaft (which, however, had only been sunk about 20 yards) in the centre of the ground; but the character of the soil, and the position of the site in regard to the surrounding population, was the best that could be obtained in the locality.

The subsoil varies considerably, about one-half the area mainly consisting of good loam, with some beds of gravel and sand, and the remaining portion of loam, gravel and clay in various thicknesses. The presence of clay causes some of the lower ground to be rather wet, but there is sufficient good ground for the requirements of the district for a considerable time.

It was not practicable to adopt the usual rectangular method of laying out burial grounds, which admits of the largest number of grave spaces being obtained in a given area, but after the ground had been carefully contoured every 2 feet, curving roads and paths were laid down at the best obtainable gradients (the steepest road being 1 in 11) with the minimum amount of

cutting and filling, and although some ground has had to be, in a sense, wasted, the result is very satisfactory.

The ground is enclosed by a random rubble native stone wall, 8 feet high above the inside level, and in some parts a retaining wall was also necessary. An upper and lower entrance is provided with ornamental wrought-iron gates.

A mortuary chapel, 36 feet by 20 feet, with accommodation for 200 persons, is provided, built of native stone throughout, and the roof is covered with red tiles. The building is heated by means of hot-water pipes.

Two of the old cottages included in the purchase, and immediately adjoining the upper entrance, were utilised for a curator's house, the appearance of the front being improved by gables, red brick dressings, and rough cast work.

A 9-inch stoneware pipe drain is carried from a point 11 feet deep, in the lower portion of the ground, to the stream closely adjoining the site, and from this drain are laid surface water drains along all the roads and paths, and in which gullies are fixed.

A large variety of ornamental trees and shrubs was planted in the belting around the ground, and in clumps, and these, contrary to expectation on account of the exposed eastern aspect of the ground, have done remarkably well. A quantity of peat from a common in the vicinity, and house refuse from the neighbourhood, was trenched into the borders some time before the planting was carried out.

The laying out of the ground, including the drainage, and the formation of the roads and paths, which are made of pebbles obtained from the excavations and works' ashes, was carried out by direct administration; and the boundary wall, etc., the buildings, and the planting, under contract.

The total cost was as follows:—

	£
Land, 19 acres at 80*l.*	1,570
Boundary walls and entrances	1,350
Conversion of old cottages	156
Mortuary chapel	850
Laying out ground and forming roads and paths and drainage	1,591
Planting	190
	£5,707

The cost for the 8½ acres laid out is equal to 566*l.* per acre.

The Local Government Board sanctioned a loan for 6000*l* for the work, repayable in 30 years.

The cemetery, opened June 1896, is not consecrated, the Corporation carrying out the work under the powers of the Public Health Act and not as a burial board, as is the case with the general cemetery for the borough.

The total number of grave spaces available in the ground laid out is about 5000, and the number of grave spaces taken to date is 551, the number of interments being 1006.

Corporate Estate.

The burgesses are the possessors of a large and valuable estate, lying within the old town and franchise, which they acquired mainly under the Town Hill and Burrows Enclosure Act of 1762. Parts of the property have been disposed of from time to time for the construction of docks, railways, and other purposes.

The present area is about 645 acres, the bulk of which is included in old leases falling in between the years 1910 and 1920, when a considerable increase of revenue will accrue to the town.

As old leases have fallen in, the property has been re-leased at greatly enhanced rentals; and whenever opportunity offered, old leases have been surrendered, and new leases granted on equitable terms.

The number of leases or separate lettings, according to the register prepared in 1903, was 582; and the revenue, from the borough accountant's last abstract of accounts, was 10,092*l*.

A considerable portion of the land which was in hand, and could be dealt with, has been let on lease and largely built over, and other parts of the estate have been laid out into streets and terraces, presenting very eligible sites for workmen's dwellings, in proximity to some of the most important works in the borough.

As the urban sanitary authority, the town possesses another valuable asset in the surplus land which was acquired in 1876–1879, for the improvement scheme under the Artisans' and Labourers' Dwellings Act, 1874. Under this scheme a large number of insanitary dwellings in the centre of the town were cleared away, the construction of new streets, and the improve-

ment of existing streets, carried out, and a large portion of the new frontages created thereby leased and built over. The most important improvement carried out under this head was the formation of Alexandra Road, a new street 300 yards in length, and 60 feet in width, upon which are erected the fine buildings containing the free public library, schools of science and art, and art gallery, and other large and important buildings.

The capital expenditure on this improvement scheme amounted to 121,992*l.*, and the revenue at present derived from leases and other lettings amounts to 1267*l.*

From 1885 to 1904 the work in connection with the Corporation estate devolved upon the Author, in conjunction with his office as borough surveyor, but owing to increased duties and responsibilities, the Corporation determined to make a separate appointment for the estate, and Mr. C. J. Howell Thomas, F.S.I., is now estate agent.

THE GUILDHALL.

The Guildhall is not centrally situated as regards the town generally, it having been located in its present position when the town was very small, and the trade of the port comparatively insignificant. The original buildings were erected in 1825, and comprised police offices and cells on the ground floor, and one court on the first floor. In 1848 extensive alterations and additions were carried out, and the present handsome façade erected from the designs of the late Mr. Thomas Taylor, architect, of London. These additions consisted of the Council Chamber, Nisi Prius Court, judges' rooms, etc., on the first floor, and municipal offices on the ground floor. Further additions were subsequently made to the accommodation for the judges and the High Sheriff on the first floor, together with offices on the ground floor.

Complaints being made from time to time as to the lack of accommodation required for the greatly increased work in connection with the assizes and the county court, and also as to the inconvenience caused by noises from railways and docks in the vicinity of the courts, the Corporation carefully considered the question of providing new buildings in a more central position, not only for the courts, but for all the municipal offices, which would have involved a very large expenditure; but it

was afterwards decided to alter and extend the present buildings, and the Author was instructed to prepare plans for the same accordingly, which were approved in 1901, and the work was afterwards carried out by direct administration in 12 months, at a total cost of 13,955*l.*

This work comprised altering the positions of the two assize courts nearer to the centre of the building, and arranging the rooms between the walls of the same and the main outer walls of the building, enlarging the central hall, and giving new or increased accommodation for the Grand Jury, the Clerk of Arraigns, barristers, solicitors, witnesses, police, the caretaker, and the general public. By surrounding the courts in this manner, and carrying the walls of the same above the skylights, the waves of sound have been entirely intercepted, and all complaints of noise removed. The ventilation of the courts and all the rooms connected therewith, as well as the Council Chamber, was most effectively carried out by a combination of the plenum and exhaust systems, according to a scheme prepared by Mr. Howard A. McFerran, A.M.I.Mech.E., of London, who had charge of the ventilation and warming of the Law Courts. Fresh air, warmed or cooled as required, is driven in by three "Sirocco" fans (made by Messrs. Davidson and Co., Ltd., of Belfast), operated by electric motors placed on the ground floor, and the vitiated air is extracted by two similar fans placed in an air-tight chamber on the second floor. The warming of the building is effected by low-pressure hot-water pipes and an American boiler. When necessary in hot weather, the fresh air is cooled by means of ice placed in specially constructed chambers.

The rearrangement of the buildings and the increased accommodation provided, together with the ventilation and warming, has been highly praised by H.M. judges and all attending the courts.

The Market.

The site of the general market in Oxford Street and Union Street, which has an area of about 2 acres, was presented to the town by the late Rev. Calvert Jones in 1826. The old buildings and uncovered roadways having become very dilapidated and quite out of date for the requirements of the town, were entirely

removed in 1895, and the existing fine covered building erected at a cost of 25,000*l.*, from the designs, selected in open competition, of Messrs. Wilson and Moxham, Architects, of Swansea.

New Central Police and Fire Brigade Station.

These buildings were completed in March last. The site is very central, being on Corporation property adjoining the public library, having an area of 1160 square yards, with frontages to Pleasant Street of 119 feet and Orchard Street of 94 feet.

This station is intended to displace the existing High Street police station, erected in 1876 at a cost of 1988*l.*, and the Goat Street police and fire brigade station, erected in 1887 at a cost of 929*l.*, and also to accommodate the greater part of the fire brigade and appliances, and two of the horses, from Oxford Street section house. The two former sites will, it is anticipated, be let for rebuilding on advantageous terms. The chief constable's offices and the police court, etc., remain at the Guildhall.

The following is the accommodation provided. On the ground floor: parade room, charge room, office, detention room, 8 cells, w.c.'s, lavatories and yards, drying room for clothing, officers' w.c.'s and lavatories, engine room, hose tower, two-stall stable and space for fodder, shed for large escape, large yard for washing engines and hose and also for giving access to cells. On the first floor: dining room, recreation room, reading room, scullery, sitting room for constable in charge, 2 bed rooms for ditto, bath room, lavatory and w.c., flat roofs over cells as drying spaces, 10 constables' bed rooms, clothing store, 2 bath rooms, w.c.'s and lavatories. On the second floor: 2 bed rooms. In the basement: heating chamber and coal store.

Morriston red brick with bathstone dressings were used in the elevations. Wood-block flooring is laid in the principal rooms on the ground floor. Cement concrete to floors of cells and corridors. Blue bricks to floors of engine room, yard, etc. The buildings are heated by means of hot water pipes and radiators, and ventilated automatically, air inlets and outlets being provided in every room. Electric light is installed throughout. Quick-opening doors, supplied by Mr. Thos. Try, of London, are fixed to the engine house.

Mr. John Williams, of Swansea, has been the contractor for

the whole work; Messrs. John Legg and Sons, of Swansea, were the sub-contractors for the heating and ventilating; Mr. Haughton, of Swansea, for the carving. The contract for the whole work was 7764*l.*, and this has only been very slightly exceeded. An amount of 8500*l.* was sanctioned by the Local Government Board for the buildings and fittings, repayable within a period of 28 years.

TELEPHONES.

Swansea is one of the six municipalities in the country which possesses a Telephone Exchange. After obtaining a report from Mr. A. R. Bennett, M.I.E.E., the Corporation applied for the licence of the Postmaster General under the Telegraphs Act, 1899, which was granted in September 1902, and the sanction of the Local Government Board was given to the borrowing of 20,300*l.* in the following month. Further borrowing powers have been given to the Corporation for main extras to the extent of 2000*l.* The system was formally opened on the 5th of November, 1903, there being at that time about 450 subscribers, and there are now instruments and lines in operation on the Corporation service to the extent of 1200, the number of actual subscribers' lines being 1057, and the number of orders still in hand is 176. The Swansea Exchange area extends over about 110 square miles, and in addition to the Central Exchange, sub-exchanges have now been established in the outlying districts of Mumbles, Manselton, Morriston, and Skewen. The balance sheet for the 18 months ended 31st March last shows a profit of 415*l.* after setting aside the required amounts for interest and sinking fund, etc.

Mr. A. R. Bennett was the consulting engineer for the work, the Author preparing the plans, etc., for the Central Exchange, which cost 2300*l.*

Mr. A. G. Mackie is the manager of the undertaking, having been appointed in December 1902, and has had charge of the carrying out of the work from its inception.

FREE PUBLIC LIBRARY, SCHOOLS OF SCIENCE AND ART, AND ART GALLERY.

In 1870 the Council adopted the Public Libraries Act, and the first Library was established in Goat Street. This building

in the course of a few years was found to be quite inadequate to meet the requirements of the town, and it was decided to erect a new building, the site selected being in Alexandra Road, on part of the land acquired under the Improvement Scheme.

The new building was erected in 1886 from the designs of the late Mr. Henry Holton, architect, of Dewsbury, and opened by the late Right Hon. W. E. Gladstone. The building is Italian Classic in style, and accommodates the Science and Art Schools and Art Gallery, in which the large number of valuable pictures presented to the town by the late Mr. Deffett Francis are placed. The total cost of this institution, exclusive of the site, was about 23,000*l.*

Parks and Open Spaces.

Swansea is well provided with parks and open spaces, the following being a list of the same:—

	Acreage.		
	Acres	Roods	Poles
Cwmdonkin Park	13	0	0
Brynmill Park	9	1	0
Llewelyn Park	42	0	0
Brynmelin Park	2	2	0
Swansea Bay Recreation Ground	8	0	27
Marine Parade	4	2	0
Victoria Park	16	1	23
St. James' Gardens	1	1	13
Dyvatty Park	2	0	33
Jersey Park	4	0	0
Total area	103	1	16

Excepting the first three named, the whole have been enclosed and laid out during recent years under the direction of the Author, at a total cost of 6033*l.* The sites of the recreation ground, the marine parade, and Victoria Park, consisted for the most part of low-lying sand banks, which were filled up, and brought to the existing levels by tipping of house and trade refuse, providing a convenient outlet for the same for a considerable time without causing any appreciable nuisance to the inhabitants of the adjoining houses.

The sites of St. James' Gardens and Jersey Park were presented to the town by William Walters, Esq., and the Earl

of Jersey, respectively, both sites being enclosed and laid out by the Corporation. Llewelyn Park was laid out and presented to the town by the late John Dillwyn Llewelyn, Esq.

The parks are now, and since October 1903, under the superintendence of Mr. D. Bliss, who has a total number of 15 men engaged on the work, and the annual expense of upkeep amounts to 2400*l.*

TRAMWAYS.

Tramways were first constructed in Swansea by the Swansea Improvements and Tramways Co. under their Acts of Parliament of 1874, 1878, 1879, and 1882, which Acts also provided for a number of important street improvements, two only of which were carried out by the company—viz. a new street 450 yards in length called Prince of Wales Road, and a widening for 100 yards of part of St. Helen's Road, and other of the improvements have since been carried out wholly or in part by the Corporation.

The route length of these tramways is 5·49 miles, being 2·94 miles single line and 2·55 miles double line, and the gauge is 4 feet 8½ inches. Mr. Joseph Kincaid, of Westminster, was the engineer.

The lines constructed under the Acts of 1874, 1878, and 1879 were laid on Mr. Kincaid's system with box section rails of 52 lb. to the yard, a portion being subsequently relaid with girder rails 75 lb. to the yard; the 1882 line being laid from the first with 75 lb. rails. Granite paving was laid throughout, the setts being principally 5 inches by 4 inches from North Wales and Ireland.

In 1898–9, the track having got into very bad condition, and the tramway company being reorganised, the whole of these lines were converted from horse to electric traction, under an Act of Parliament obtained by the company in 1897. The company carried out the work themselves by direct administration, Messrs. Kincaid, Waller, and Manville being the engineers, the Author supervising the work on behalf of the Corporation. The 52 lb. rails were entirely taken up, and 75 lb. substituted, and the paving, after being re-dressed, was relaid on proper concrete foundations. The lines previously laid with 75 lb. rails were allowed to remain, and electrical bonds were inserted.

The maximum gradient of these lines is 1 in 22, and the sharpest curve 40 feet radius.

The tramway company established a power station at their main depot on St. Helen's Road, the plant consisting of two Babcock water-tube boilers, two Ball and Wood horizontal engines coupled direct to two Westinghouse, and one multi-compound, dynamos, with a capacity of 620 K.W.

In 1902 the Corporation obtained an order under the Light Railways Act to construct "The Swansea and District Light Railways," and in the same year obtained power under the Swansea Corporation Act to make certain extensions of the tramways; and most of these lines have recently been completed, the Author having charge of the permanent way and street improvements, and Mr. Prusmann, the Borough Electrical Engineer, having charge of the electrical equipment.

The lines constructed under the Light Railways Order are as follows:—

1. From Brynmill, on the extreme western side of the borough, through the centre of the business portion of the town, and across the North Dock Lock and New Cut bridges, to Danygraig, on the eastern side of the borough—a route length of 2·85 miles, a junction being effected with the company's lines at Hospital Square.

2. From Sketty, through the principal residential portion of the borough, to a junction with the company's line at Albert Hall—a route length of 1·73 miles.

3. From the borough boundary at Morriston, through Morriston, joining the company's line on Neath Road—a route length of 0·91 mile.

The line constructed under the Corporation Act is through Brynhyfryd and Pentre to a junction with the company's line at Carmarthen Road—a route length of 1·33 miles.

The total length of all the new lines is 6·82 miles, being 3·51 miles double line, and 3·31 miles single line. The total length of track reduced to single line is 10·33 miles.

Certain street improvements were necessary, viz. road widenings on Sketty Road, Port Tennant Road, and at Brynhyfryd, the land for which was obtained by private agreement and arbitration.

Considerable opposition was taken by property owners and ratepayers in part of Oxford Street and Temple Street to the

proposed lines in these busy and comparatively narrow streets (the carriageways of which vary from 20 feet to 25 feet in width); but since the work has been completed, double lines being laid, the policy of the Corporation appears to have been entirely justified, as the tramway traffic and the ordinary traffic are carried on with very little if any inconvenience to tradesmen in these streets, and the advantages to the inhabitants generally in regard to this through central line are very apparent.

It was also urged by opponents of the scheme, that it would be a mistake to lay down new lines practically parallel to the existing tramway along St. Helen's Road, at a distance in one case of only about 70 yards, and the other case about 200 yards; but this anticipation has not been fulfilled, as the traffic results of the new lines are most satisfactory, and much-needed relief has been afforded to the old line on St. Helen's Road, which was formerly much congested.

The lines are leased by the Corporation to the tramway company for terms of twenty-one years at rents which cover the interest and sinking fund on the expenditure, and are worked by the company in conjunction with the old lines.

The steepest gradients are as follows:—

Bryn Road	1 in 19	for a length of	362	feet.
Temple Street	1 in 18	"	198	"
Castle Bailey Street	1 in 16	"	158	"
Eversley Road	1 in 18	"	736	"
Sketty Road, Uplands	1 in 15	"	130	"
Walters Road	1 in 21	"	610	"
Mansel Street	1 in 26	"	210	"
Martin Street, Morriston	1 in 16	"	190	"
Church Square, Morriston	1 in 17	"	130	"
Woodfield Street, Morriston	1 in 22	"	440	"
Llangyfelach Street	1 in 14	"	128	"
Llangyfelach Road	1 in 25	"	318	"

The sharpest curves taken in centre of track, are:—

	Radius.
Bryn Road and Gorse Lane	52 feet
Brynmor Road and Gorse Lane	40 "
Beach Street and Oxford Street	50 "
Temple Street and Castle Bailey Street	52
Wind Street and Quay Parade	52 "
Albert Hall	42 "
Eaton Road and Penfilia Road	42 "
Church Square, Morriston	46

The following are particulars relating to the construction of the track.

The British Standard specification and sections were adopted for the rails, those for straight track being 95 lb. to the yard, and for curving track 101 lb. to the yard, both being 6½ inches deep.

The rails and fishplates were manufactured by the North Eastern Steel Co., Ltd., from basic steel, the average chemical composition of which was as follows, complying with the specification:—

Carbon	0·43 per cent.
Manganese	0·83 „
Silicon	0·09 „
Phosphorus	0·061 „
Sulphur	0·062 „

The required physical tests were also complied with.

The points, crossings and special work are of manganese steel, manufactured by Messrs. Allen and Co., of Sheffield. The tie-bars, manufactured by Messrs. Bayliss, Jones, and Bayliss, are spaced 7 feet 6 inches apart for granite paving, and 6 feet apart for wood. Dicker joints were used throughout with Ibbotson's patent locknuts.

The cement concrete foundation 6 inches thick, in the proportion of 6 to 1, was laid after the rails had been fixed and beater packed tightly to the underside of the same.

A considerable portion of the track is paved with wood, mainly Jarrah, but for steep gradients creosoted pine is laid. The blocks, 5 inches deep, are laid with about ⅛ inch joints, run with hot pitch and creosote oil, and afterwards with cement grout. The remainder of the track is paved with 5 inch by 4 inch syenite setts, principally from Port Nant, North Wales, the joints being run with pitch and creosote oil in the usual manner.

Trapped drain boxes are inserted where required on the track and connected with the public sewers, and the movable point boxes are also drained.

Electrical bonds, as and where specified by the Borough Electrical Engineer, are inserted.

The alteration of gas and water-mains and services met with in the construction of the track involved considerable delay and expense, as no doubt is the case generally in old towns having narrow streets.

In connection with the work, the old hog-backed macadamised surface of most of the roads and streets had to be considerably lowered, to suit the cross section required for the track and the wood or granite paving. The contour adopted was as far as possible one-sixtieth of the width of carriage-way; but this had to be modified to suit the varying differences of level between kerbs on either sides, and in some cases it was necessary to adjust the levels by altering kerbs, channels, and paving.

The total cost of the track work, including the alterations of levels of the roadway, gas and water mains, sewer manholes, etc., amounted to 65,300*l.*, being equal to 6025*l.* per mile of single track.

The cost of the street improvements, including land and works, amounted to 1956*l.*

The contractors for the work were Messrs. Dick, Kerr and Co.

Paving Sides of Streets on Tramway Routes.

The Corporation took the opportunity of having the full width of certain streets paved with wood or granite at the same time as the tramway work was proceeding, the work being carried out by the same contractors.

These streets are as follows:—

	Lin. yds.	
Oxford Street	560	(Jarrah)
Lower Oxford Street	613	(Granite)
Temple Street and Castle Bailey Street ..	137	(Pine)
Castle Square	50	(Jarrah)
Wind Street	263	(Jarrah)
Quay Parade	130	(Granite)
Harbour Trust Road	155	(Granite)
	1908	

The full width of the roadway at certain of the passing places was also paved with wood or granite.

The Local Government Board sanctioned an expenditure of 10,354*l.* for this work, the terms of repayment being for granite 19 years and for wood 9 years.

DISCUSSION.

The PRESIDENT: I note with some interest that the Swansea Corporation has found that a double track in roads of less than 24 feet wide offers less obstruction than a single line of tramway. There are many towns where it is difficult to hammer that into the public.

Mr. J. T. EAYRS: I have pleasure in moving a hearty vote of thanks to the Author. I am rather astonished to hear there is any difficulty in getting road metal broken to a regular gauge or shape, either by machine or hand. That difficulty does not arise in many places. I know in one county the idea of the surveyor who has charge of the roads is that where we have modern appliances for scarifying and steam rolling, the necessity of uniformity of gauge in the stone, is not so great as previous to the adoption of steam rolling. I notice that the footpaths are paved with Irish and native flags. Many years ago I found Irish flags very brittle, and that they wore slippery. I should like to know whether the Irish flags are as satisfactory as Yorkshire. In regard to the making of tar macadam, I do not agree that the stone should not be dried. I think it is very necessary that the whole of the moisture should be evaporated before tar and creosote oil are mixed with the aggregate. The practice in most towns is to dry over hot plates with a flue underneath, and not as described here, by covering the beds with coke breeze. With reference to private street works, I think surveyors generally will deprecate the method of allowing owners of property to do the work piecemeal. I think it is far better for the owners of the property to allow the Corporation to do the work and make one job of it. I do not know what steps have been taken to guard against possible pollution of the fisheries from barging the refuse to sea, but I should say that great care ought to be exercised in doing this. As to the culverting of the Burlais Brook, Mr. Bell proposes to line it with a blue brick lining to withstand the scour and the acids in the water. Will Mr. Bell tell us the nature of the acids sent down this watercourse? If certain acids are used, it might be a word of warning to say that they tend to destroy Portland cement and lime, and eventually the lining might have to be renewed altogether from the joints being destroyed by the acids.

I have known cases where sulphur has been used and run into the joints in order to prevent deterioration from that cause.

Mr. P. R. A. WILLOUGHBY: I have pleasure in seconding the vote of thanks. I should like to supplement the remarks of Mr. Eayrs about the heating of stone prior to use for asphalt. The question has arisen at Pontypridd where we are now asphalting 14,000 yards of school playground. The Asphalt Company have undertaken to quadruple their guarantee on condition that the stone is not fired, but used reasonably dry straight from quarry.

Mr. J. S. PICKERING: Mr. Bell is to be congratulated upon the economical repair of his roads. I understand they can be scarified and recoated with syenite costing 8*s* 2*d*. per ton at 11*d*. per square yard, which is very low. Mr. Bell supplements this by saying that the average cost of the roads throughout the borough is only 80*l*. per mile. I think very few manufacturing towns repair their roads at anything like so low a figure. I cannot congratulate the Corporation upon the system of collecting the refuse. It is most objectionable for this to be put in the streets in various kinds of receptacles to be removed in an irregular manner by the collectors. I am surprised to find that Swansea has been so far behind other towns in having only recently erected a destructor. The deposit of refuse on tips which become building sites is most insanitary, and the sooner it is done away with in every town the better. The question of utilising the refuse from the destructor should be of secondary importance. The first consideration should be to dispose of the objectionable matter in a sanitary manner. In Swansea the destruction of the refuse appears to be carried out efficiently and at the same time some use is made of the clinker. Although I have seen many destructors, I do not think I have seen a better clinker than is produced at Swansea. Those of us who have bacteria beds to construct would be glad of such material as we have seen to-day. I think the Corporation will, if they wish, be able to dispose of it to some of the inland towns for this purpose. I was particularly interested in seeing the process of concrete block making and think this will be found a profitable way of utilising the clinker. The material may also be put to use in making concrete flags. I think Mr. Bell is adopting the very best material he could in lining the culvert with blue bricks as they will stand almost any kind of wear, and if there is any acid

of the nature Mr. Eayrs refers to, this should not be allowed to enter the culvert at all. Mr. Bell will find the concrete made from destructor clinker quite satisfactory, if the lime which is generally present in the clinker is slaked before this is used in the concrete.

Mr. J. COX: I would like to ask as to the life of tar macadam. To my mind it is nothing like so good as a natural stone pavement. I have had some difficulty with tar macadam, and my experience is that after seven or eight years it perishes.

The PRESIDENT: Is it footpath or carriageway paving?

Mr. COX: Footpath paving.

The PRESIDENT: I am in agreement with Mr. Eayrs that if you have any acid of any particular strength passing through this culvert, it will be necessary to take some special precaution to protect the cement. I know nothing better than blue bricks for the lining, but it may be necessary to have molten pitch or molten sulphur composition joints. As to the life of tar paving I am acquainted with tar paving that has been down twenty years. It is worn hollow, as regards profile, but perfectly sound; as sound as flags. With the ordinary facing every three years at a cost of about 3*d.* per square yard, you can make tar paving last a considerable time. Of course it is not suitable for town roads with heavy traffic, but for suburban roads, or roads where the traffic is of moderate character, I know nothing better. On roads of very light traffic, I have known it fall to pieces because there was not enough traffic to keep it in compression.

The vote of thanks having been recorded by acclamation,

Mr. G. BELL, in reply, said: It has been a pleasure to me to prepare the paper. As to Mr. Eayrs' remarks as to Irish flags being brittle, the flags we used came from the west coast, from Liscannor, cost 4*s.* per yard, and were perfectly satisfactory. They were certainly not brittle and did not become slippery. The reason we have not gone on using them is that we get some very good flags in the Swansea Valley at about 3*s.* 9*d.* per yard. As to the drying of the stone for tar macadam, I know it is well to get the moisture out of the stone, and we tried to do it as far as possible, but we get very satisfactory results from the way it is now done. The method of putting the stone in beds, and making a fire on the top is a rather common one. Now we keep the stone as dry as possible and drop the firing. As to the barging of the refuse to sea that is a matter which

is under the consideration of the Council. I am sure the Council will take every precaution, not only for the protection of the fishing industry, but of every other industry. I do not think there is likely to be any nuisance at all. It would be taken three miles beyond the Mumbles Head where the tide will get hold of it, and carry everything away. As to the lining of the culvert with blue bricks, the precaution I had to take was that it should stand the scour and also the acids in the water. The acids are naturally very weak, being sulphuric and other acids which are used in the tin works above the site of the culvert, and the storm water flowing down will dilute them to such an extent that I do not think there will be any deleterious effect on the blue bricks or the cement joints. Mr. Willoughby has said contractors do not agree with the heating of the stone for making tar macadam, which supports what we are doing in Swansea. We should be only too glad if householders would adopt proper receptacles for ashes and refuse. The putting out of refuse in the sheds is not very satisfactory, but there are a good many other towns in the same position. The life of tar macadam for roadways in Swansea has varied considerably. Some in wide roads and narrow passages has lasted eight or ten years with a little repair; and as to footpaths we have had some down eight or ten years which have not been repaired at all. Tar paving is only put down where the Corporation do not see their way to put down a permanent paving, and of course it is not so satisfactory as stone.

SWANSEA ELECTRICITY UNDERTAKING, AND TRAMWAY EQUIPMENT.

BY C. A. L. PRUSMANN, M.I.E.E., A.M.I.M.E.,
BOROUGH ELECTRICAL ENGINEER.

DESCRIPTION OF WORKS.

BUILDINGS.

THE buildings situate at the Strand Generating station comprise the following:—

Pump room.
Boiler house.
Economiser shed.
Engine room.
Battery room.
Test room.
Mess room.
Engine room.
Store room.
Coal stores.
Joiner's shop.
Chief engineer's office.
Assistant and charge engineer's office.
Clerk's office.
Timekeeper's office.
Bath room.
Lavatories.
Weigh room.
Passages and corridors.
Yards and Chimney shaft.

Pump Room.—The pump room is equipped with:—

1. One three-throw pump by Messrs. Yates and Thom, driven by a shunt-wound motor, by Messrs. The British Schuckert Company. The pump is capable of delivering 2000 gallons of water per hour through an economiser, against a boiler pressure of 160 lb. per square inch.

2. One three-throw pump by Messrs. Yates and Thom, driven by a single cylinder engine by Messrs. Yates and Thom.

The pump is capable of delivering 2000 gallons of water per hour through an economiser, against a boiler pressure of 160 lb. per square inch.

3. One steam driven "Weir" pump, capable of delivering 4000 gallons of water per hour through an economiser, against boiler pressure of 160 lb. per square inch.

All the above pumps receive their supply of water from a tank situated above the pump room, which tank is constructed in two divisions; the whole having the following dimensions, 28 feet by 7 feet by 11 feet. This tank is supplied with water from the town mains, passing through "Kennedy" water meters.

The steam supply to the pumps is in duplicate, and the arrangement of feed-pipes is such as to admit of the pumps delivering boiler feed to the boilers, either direct into the boilers or through the fuel economiser.

Boiler House.—The boiler house is equipped with :—

Five "Lancashire" boilers, by Messrs. Yates and Thom.

Each boiler is 30 feet long, and 7 feet 6 inches diameter.

They are designed for generating steam at a pressure of 160 lb. per square inch.

The furnaces are arranged for hand-firing, natural draught being employed.

The fuel is tipped in front of the boilers through the iron doors adjoining the railway siding, along which the coal trucks are brought.

Each boiler is fitted with duplicate water-gauges, duplicate boiler feed check valves, and a pressure-gauge.

The boilers supply steam to the engine room by means of duplicate ranges.

Economiser Shed.—The economiser shed is fitted with an economiser by Messrs. Green and Sons, consisting of 190 tubes, designed for working in conjunction with the aforementioned boilers.

This economiser is fitted with full complement of valves, fittings, etc.

The scrapers of the economiser are driven by a 1 horse-power motor, by Messrs. The British Thomson-Houston Company.

Engine Room.—The present engine room is equipped with the undermentioned machinery, plant, switchgear, etc. :—

1. One 75 K.W. shunt-wound multipolar British Schuckert dynamo, coupled direct to a high-speed three-crank compound

"Willans" enclosed-type engine, running at a speed of 450 revolutions per minute.

This steam generator is suitable for lighting purposes only.

2. One 225 K.W. shunt-wound multipolar British Schuckert dynamo, coupled direct to a marine triple expansion open-type engine, by Messrs. J. and H. Maclaren, running at a speed of 150 revolutions per minute, and capable of developing 450 I.H.P.

This steam generator is suitable for tramway and lighting purposes.

3. Two 600 K.W. shunt and compound wound multipolar "British Westinghouse" dynamos, coupled direct to two marine triple-expansion open-type engines, by Messrs. J. and H. McLaren, running at a speed of 125 revolutions per minute, and capable of developing 1100 I.H.P. each.

These steam generators are suitable for both lighting and tramways.

The above engines are designed for a pressure of 160 lb. per square inch at the engine stop-valves.

All four engines are arranged to work either condensing or non-condensing.

The 75 K.W. steam generator is fitted with a three-throw jet condenser, by Messrs. Yates and Thom, which is driven by means of a 15 B.H.P. shunt-wound electric motor, by Messrs. The British Schuckert Company, coupled direct to the condenser.

The 225 K.W. steam generator, drives, by means of four 1½-inch ropes, a jet condenser by Messrs. Yates and Thom.

Each of the two 600 K.W. steam generators, drive, by means of links worked off the intermediate crosshead, a surface condenser by Messrs. McLaren.

In all cases, the circulating water for the condensers, is obtained from the North Dock.

Before leaving the main steam engines and dynamos, it may be of interest to note that when the Destructor works engine and dynamo are in operation, the condition of affairs will be as follows: One of the 600 K.W. generators will be utilised for lighting. The 225 K.W. generator at the Destructor works will supply those tramways for which the Corporation have to find electrical energy, leaving at the Strand station one 600 K.W. generator, to act as a stand-by to both lighting and tramways, and a 225 K.W., and a 75 K.W. generator to meet immediate future demands for lighting.

It will, therefore, be seen that both the lighting and the tramways will be worked with a minimum of stand-by plant, which means an important reduction in the amount of capital charges.

Leaving the main generators, and turning to the smaller electrical plant, this consists of:—

4. One motor booster for the purpose of charging the batteries. The booster side having a capacity of 162 amperes at 185 volts. The motor side consists of a shunt-wound motor. The combined motor booster is by Messrs. The British Schuckert Company, running at a speed of 765 revolutions per minute.

5. One 40 K.W. shunt-wound balancer, by Messrs. The British Schuckert Company.

This machine is utilised for taking up the difference in load on either side of the three-wire system, and runs at a speed of 550 revolutions per minute.

6. One negative tramway booster, for the purpose of keeping down to within Board of Trade requirements, the difference in pressure along the tram rails.

This booster has a capacity of 250 amperes at 35 volts, and is by Messrs. D. Bruce Peebles and Company.

7. One milking booster.

This is a portable booster for charging up individual cells of the battery, made by Messrs. The British Schuckert Company.

8. The main lighting switchboard.

This is situated on the south wall of the engine room, and is by Messrs. The British Schuckert Company, and comprises:— Three main feeder panels, one battery panel, one balancer panel, one total output panel, one motor booster panel and eight main feeder panels.

In addition to the above panels on the main lighting switchboard, there are two generator panels, and one feeder panel, by Messrs. The British Westinghouse Company.

The whole of the above mentioned are fitted with the full complement of recording instruments, safety devices, switches, fuses, general instruments, and appliances.

The street arc-lighting board is distinct from the main board, and is arranged for controlling six series of arc lamps, consisting of nine lamps to a series.

9. The new tramway switchboard.

This is situated on the east wall of the engine room, and is by Messrs. Dorman and Smith. The whole of the switchgear, instruments, etc., on this board are mounted on blue marble.

The board comprises: One Board of Trade panel; one negative booster panel; one panel for the motor of the negative booster; one total output panel; and two feeder panels, containing two feeders on each panel.

The back of this board is particularly free to access, for inspection, overhauling, etc.

10. The steam to the engines is carried along the east and west sides of the engine room by means of duplicate steel pipes on either side, fitted with full complement of valves, etc.

11. The engine room is spanned by means of a ten-ton hand travelling crane, by Messrs. Carrick and Ritchie.

It will be observed that a certain space of the engine room has not been tiled. In this space, it is proposed to fix the high tension alternators, driven by continuous-current low-tension motors for supplying electrical energy to the outlying districts.

Battery Room.—The battery room is situated on the east side of the engine room, and contains 258 cells, divided up in two halves on either side of the three-wire system.

The capacity of the battery is 650 ampere hours, the battery being of Messrs. The Tudor Accumulator Company's make.

Test Room.—The test room is situated on the ground floor on the south side of the engine room, and is provided with numerous instruments for carrying out meter, arc lamp, mains installation and dynamo tests.

Coal Stores.—The present coal stores are adjacent to the south side of the boiler house, and are capable of storing approximately 200 tons of coal.

Feeders and Distributing Mains.

The supply of electrical energy to the town for lighting purposes is delivered by means of—

1. Eight main feeders and six sub-feeders.

The whole of these feeders are of the hygroscopic, triple concentric, lead-covered type, and are drawn into 3-inch " Albion Clay " and " Doulton " earthenware ducts.

The cables are by Messrs. Callender's Cable and Construction

Company, and vary in size from the largest, 0·4, 0·2, 0·4 square inch, to the smallest, 0·2, 0·1, 0·2 square inch.

2. Main feeder cables crossing the North Dock and the New Cut.

These are of the single-core, submarine, double-wire, armoured type, by Messrs. Callender's Cable and Construction Company, and are laid direct in the bed of the North Dock and New Cut.

3. Distributing cables.

These are fed by means of the above-mentioned feeder cables, and are of the fibre insulation, hygroscopic, lead-covered type, laid in U-shaped earthenware troughs, filled in with bitumen, and finally covered by means of tiles. The cables have a sectional area of 0·1, 0·06, 0·1 square inch.

4. Service cables.

The service cables are triple-concentric, and concentric, hygroscopic fibre insulation, lead covered, and laid in a similar manner to the distributing cables.

The sectional area of the service cables used are: 0·022 concentric and 0·05, 0·025, 0·05 triple concentric.

5. Feeder cables.

These are connected to the distributing cables by means of feeder pillars fixed above the surface of the footways, and when these distributing cables are required to be disconnected, this is effected by means of underground disconnecting network boxes, fitted with footway and roadway frames and covers.

All feeder pillars and underground fittings are by Messrs. Callender's Cable and Construction Company.

CONSUMERS' METERS AND INDICATORS.

Consumers have fitted in their premises:—

1. Meters made by one of the following firms:—

Messrs. Chamberlain and Hookam, Ferranti, Aron Meter Company, Reason Company, and The Bastian Meter Company.

2. Indicators of the "Wright" type, made by Messrs. The Reason Company.

3. "Reason" fuse-boxes are used in consumers' premises.

Equipment in Engine Room at Destructor Works.

The equipment at the Destructor Works engine room, which is to supply electrical energy to the new tramways and light railways, will consist of a 225 K.W. engine and dynamo. This engine and dynamo have been removed from the Strand generating station, and so altered to enable it to meet tramway requirements.

A tramway switchboard and booster will be installed, the switchboard to be a duplicate of the one at present in use at the Strand station.

The steam to the generating set at these works will be obtained from the boiler, which in the ordinary way, will generate steam by means of refuse, and the steam pipes connecting this boiler with the steam engine, will be laid underground from the boiler in the Destructor Works to the engine room.

The engine room at the Destructor Works is equipped with an 8-ton crane, by Messrs. Herbert Morris and Bastert.

The building at these works as far as the electricity department is concerned, comprises: engine room, offices, stores, and lavatories.

Tramway Overhead Equipment.

The Swansea Corporation have nearly completed some 12 miles of electric tramways and light railways. The bulk being now in operation, and the remaining section it is hoped will be open in the near future.

The overhead equipment of these tramways and light railways has been carried out by span wire, and bracket-arm construction; no centre poles have been employed, and no bracket arms over 15 feet 6 inches have been used.

The line has been erected for straight under-running trolleys, with fixed trolley heads.

Owing to the peculiar atmospheric conditions which prevail in Swansea, on account of the various works in the neighbourhood, it has been deemed advisable to use only phosphor bronze for span and guard wires, as against the usual practice of steel wire, as it has been found that the life of a steel wire under the conditions in Swansea is very short indeed.

time, and therefore, in the meantime, the capital outlay of the draw-pits and frames and covers is saved, and if these are required at a future date, they can very easily be installed.

It is interesting to note that the whole of the tramway cables after entering the Strand generating station, are kept absolutely distinct from all lighting cables, and are laid in a separate trench very easy of access. It is, therefore, quite impossible, in the case of an emergency, to confuse the two sets of mains.

DISCUSSION.

The PRESIDENT: I should like to ask Mr. Prusmann whether he has formed any opinion as to the relative value of anthracite and bituminous coal for steam raising.

Mr. P. R. A. WILLOUGHBY: I should like to ask with reference to the electric installation at the destructor whether any working arrangement has been come to between one department and the other as to the benefit of the steam produced by the destructor. The question has arisen in my district, where we are running our tramways by coal fed boilers and now we are erecting a destructor to be used in conjunction with the electricity station. I think the health department should be credited with the amount of water evaporated and converted into so many pounds of steam or units of electricity and have a debit and credit account throughout the year.

The PRESIDENT: The details of the automatic connection and disconnection of the current at the drawbridge and swing-bridge over the river and dock will be of very great interest. You have a very difficult problem there, and it will be very interesting to know how it has been solved.

Mr. C. A. L. PRUSMANN, in reply, said: I have had no actual experience in the use of anthracite coal. All coal used at these works is small. Our coal costs for year ending March 1905, is 0·28*d.*, and, I believe, one of the lowest in the kingdom. With reference to steam from the destructor, what we have done is to go to the Streets Committee, and say "Will you give us a certain amount of steam at a certain price, based upon what it costs per unit turned out on the switchboard?" The exact price has been discussed, but I do not think it would be quite wise to name that price at the present time, though I believe it will be bene-

Corporation works in the event of a breakdown happening at the Corporation works, and *vice-versâ*. By adopting this course, it will be seen that the amount of stand-by plant is reduced to a minimum, as the spare machinery at the Strand station will act as a stand-by to both tramways and lighting. It is of course assumed, and the Author believes safely so, that a breakdown to lighting and tramways will not occur simultaneously.

The remaining points in connection with the new light railways which should be mentioned are namely :—

Running cars over the drawbridge spanning the North Dock lock, and the swing-bridge crossing the river Tawe. In the case of both these bridges, the current is automatically disconnected and connected, when the bridges are open and closed, in such a manner as to make it impossible for a car to approach the dock or the river to within a dangerous distance while the bridges are open.

The Author is not aware that a similar case has had to be dealt with in any town in the United Kingdom.

The work of installing the overhead equipment has been entrusted to Messrs. Dick, Kerr and Co.

It is interesting to note that all the tramway poles have been made in the town, namely, by Messrs. The British Mannesmann Tube Company.

Tramway Cables.

The whole of the tramway cables for the Corporation's new tramways and light railways consist of vulcanised, non-hygroscopic, unsheathed cables, laid solid in 2½-inch earthen troughs filled in with bitumen, and finished off with tiles on top.

Alongside all of these cables in every case, have been laid a number of "Albion Clay" 3-inch earthenware conduits, so that in the event of extensions being required in the future, cables will be able to be drawn into these spare ducts without the re-opening of any roadway except at intervals of approximately 100 yards, where it may be required to build draw-pits.

This, however, will cause very little, if any, inconvenience to traffic of any description.

The reason that these draw-pits have not been put in during the laying of the spare ducts, is on account of the fact that possibly the spare ducts may not be required for a considerable

time, and therefore, in the meantime, the capital outlay of the draw-pits and frames and covers is saved, and if these are required at a future date, they can very easily be installed.

It is interesting to note that the whole of the tramway cables after entering the Strand generating station, are kept absolutely distinct from all lighting cables, and are laid in a separate trench very easy of access. It is, therefore, quite impossible, in the case of an emergency, to confuse the two sets of mains.

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ficial to both the Streets Committee and the Electricity Committee. It is a kind of compromise. I would like a little more, and no doubt Mr. Bell would have liked a little more. With regard to the overhead electric tramway equipment on the bridges, I do not think there is any place in the country where they have had to deal with two bridges, one a drawbridge and the other a swing-bridge. The drawbridge has a peculiar movement which is difficult to overcome, as far as the tramway equipment is concerned. In about ten days that difficulty will, I hope be surmounted, and the whole of the work completed for the actual working of the cars.

SWANSEA WATERWORKS.

By R. H. WYRILL, M. Inst. C.E., Borough and Waterworks Engineer.

The Act under which the existing Swansea waterworks were constructed was obtained in 1860 by the Swansea Local Board of Health. The Lower Lliw reservoir was constructed under this Act, being commenced in March 1862 and completed and overflowing in October 1867. This reservoir was constructed in a valley of denudation in the coal measures, and is situate about 10 miles north from Swansea. There are workable seams of coal under the whole of the reservoir and over the greater portion of the watershed. The gathering ground is about 1740 acres; the embankment is 200 yards long; the greatest depth of water, 64 feet; and the bottom of the foundations of the trench are about 99 feet below top bank level. The width of the puddle is 20 feet thick at the bottom and 10 feet thick at the top. The total cost of this reservoir was 113,000*l.* In the spring of 1873 it commenced to leak, and as it was the only supply to Swansea, the Blaenant Ddu reservoir was constructed under the Act of 1873; this reservoir was commenced in September 1874, and was completed in August 1878, and for the first time overflowed in August 1879. The Blaenant Ddu reservoir contains 127,000,000 gallons; the gathering ground is 735 acres; the greatest depth 57 feet 4 inches; length of embankment 132 yards, and cost 97,000*l.* The trench was sunk entirely through the rock of the coal measures, and was filled up with hydraulic lime concrete to the surface of the ground, and on top a puddle wall was constructed in the usual manner. On the completion of this reservoir, it alone was used for the supply of Swansea, and the repairs to the disabled Lower Lliw reservoir were taken in hand. A shaft, 30 feet by 20 feet, was sunk from the top of the embankment on the line of the puddle trench, and carried down to the bottom. It was then found that concrete had been

placed in the bottom of the trench to form a footing for the puddle to rest upon; but this was not of good quality and was porous, and the springs from the adjoining hill sides when under the influence of heavy rains, had caused springs to set up which freely passed through the concrete and eroded the bottom of the puddle wall, and this continuing, the puddle set from time to time and a large portion of it had been washed away, and in consequence of this the reservoir leaked. Cement concrete was put in the bottom of the trench; the shaft from top to bottom was filled in with good class puddle, and an iron pipe was laid, passing up the shaft 17 feet high, which finally discharged to the drains underneath the outer slope of the embankment. These repairs were commenced in June 1879, and completed about October 1880. Sir Robert Rawlinson was the engineer for the Lower Lliw reservoir; and Mr. Edward Cousins was the engineer for the Blaenant Ddu reservoir, and also for the repairs to the Lower Lliw reservoir.

The Lower Lliw reservoir continued water-tight up to January 1883, when it again leaked in the bottom of the trench.

The Swansea Corporation having been unfortunate in their waterworks, it being proved that year by year the proportion of collectible water on their gathering ground was growing less as the coal workings under the watershed were extended, it became a serious consideration whether it was worth while expending any more money on any works situated on coal measures. The Author reported in 1883 on several new water schemes, but the law agents of the Corporation holding the opinion that no Parliamentary powers for a new scheme would be granted, until it was shown that all the resources of their existing watershed were exhausted, it therefore devolved upon the Author to devise such a scheme as would make available all the rainfall of the old, or Velindre, watershed. He, therefore, prepared plans for a new storage reservoir at a point which would be practically unaffected by any coal workings. Parliamentary powers were obtained for this reservoir in 1884, and as the water requirements of Swansea were imperative, the Author immediately designed and constructed the Upper Lliw reservoir. This reservoir has a water area of 35 acres, a depth of 68 feet of water, and contains 305,000,000 gallons. The reservoir is constructed in the shales and sandstones of the coal measures, immediately

overlying the Upper Pennant series, and the embankment is placed across the river Lliw, two miles above the old Lliw reservoir. The trench is carried down 12 feet below the level of the stream in the centre of the embankment, 60 feet at the deepest portion of the east end, and 90 feet at the deepest portion of the west end of the trench.

For about two-thirds its length the trench is founded in hard shale, the remaining one-third at the east end being on hard rock. A lining of blue brickwork in cement and cement concrete is provided, where the shale required it, to prevent the action of any springs on the puddle. The puddle trench is 26 feet wide at the deepest part, decreasing to 12 feet at the ends and the top of the puddle wall. The total length of the puddle trench is 233 yards, and the quantity of puddle used in the trench and puddle wall is 35,000 cubic yards.

The discharge tunnel is 113 yards long, and is driven through the solid strata round the west end of the embankment. The tunnel commences in the valve shaft, which is constructed of blue brickwork in cement, with a handsome circular-domed valve-house of stone. In this valve-house is placed the machinery for working the valves commanding the discharge from the reservoir. The valves are worked by direct-acting hydraulic cylinders placed over each valve, the necessary water pressure being obtained from a spring found on the hillside. The only manual labour necessary to work the valves is to pull over a small lever of the ordinary signal-box pattern, which opens or closes the water ports, and raises or lowers the valves. The valves are all in duplicate.

Water for town supply is decanted at two levels, 21 feet 6 inches and 41 feet 6 inches below the top water level of the reservoir. The decanting valves are 18 inches in diameter, and at a level of 68 feet there are 40-inch valves for drawing off the lower portion of the reservoir, or assisting the discharge of flood waters.

After the water from the reservoir leaves the tunnel it passes into the outlet channel, and either passes down the river into the Lliw reservoir, or can be diverted into the gauge basins, where it is measured and sent to Swansea, or into either of the other reservoirs.

The embankment is 75 feet deep in the middle, and on the water side has a stone toe 25 feet high, which contains about

15,000 cubic yards. The embankment on the water side is covered with broken stone, and on this is laid stone pitching varying from 12 inches thick at the bottom to 18 inches thick at top water level. This pitching is to protect the embankment from wave-wash. The inner slope of the embankment is 3 to 1, and the outer slope 2½ to 1, with two benches 30 feet wide and 14 feet wide, the outer slope being soiled, and the whole of the outer portion of the embankment being drained.

The embankment is 158 yards wide at its base, and 8 yards wide at the top, and contains about 210,000 cubic yards of material.

The overflow weir at the east end of the embankment is of segmental stone steps with movable stop planks and sluice placed on the top step, and worked from the footbridge.

The overflow channel consists of 18-inch pitchings in the bottom with 15-inch at the sloped sides, and the weir and overflow channel are capable of discharging 12 inches of rainfall per day, from the gathering ground—in addition to the discharge from the flood valves, which valves alone are capable of emptying the reservoir in three days.

The height of the overflow weir is 616 feet above Ordnance Datum.

The average rainfall at this reservoir is 53·42 inches per annum.

The whole of the Upper Lliw reservoir works and pipe lines was constructed by the contractors under the direction of the Author.

The water from these reservoirs is unusually soft, being about 1 degree of hardness in winter time and 1½ degree in summer time, when there is a large proportion of spring water.

The yield from these reservoirs, being in an average year about 2,664,000 gallons, and in a very dry year about 2,000,000 gallons, is quite inadequate for the requirements of Swansea, which has a population at the present time of about 100,000 inhabitants and many important manufactories. The Swansea Corporation therefore determined to boldly face the difficulty, and to construct works which would give them an ample supply of pure water for many years to come, and would be entirely free from all trouble as to mineral workings; in order to do this, it was necessary to construct works nearly thirty miles distant, and the river Cray was selected as being the best source, as the

rainfall was known to be heavy, the elevation great, the watershed being entirely mountain pasture with only two small shepherds' cottages, and the facilities for the construction of the works being good.

The watershed consists of 2640 acres of excellent gathering ground in the wettest portion of South Wales. The question of rainfall will be referred to later.

Parliamentary powers to carry out the works were obtained in 1892, but in passing through Committee clauses were imposed by which any water authority, any part of whose district is within one mile of the main pipe line, may demand and obtain a supply for their requirements, leaving a prior right to Swansea of 25 gallons per head. The authorities referred to include the whole population of the Swansea Valley and the Swansea District. These populations are situate on the coal measures, and their local waterworks are also feeling the effects of the coal workings which will in time destroy their springs as the coal is worked, and they will rely upon the Swansea works for their supply. This additional population at the present time numbers about 60,000, and is growing rapidly. The demands upon the Cray works are, therefore, much more extensive than was originally contemplated, and the pipe lines have been increased in carrying power.

The Act of 1892 provided for the construction of a storage reservoir, tunnel, pipe line, and service reservoir; these works are now approaching completion.

The storage reservoir will contain 1,000,000,000 gallons of water and be 100 acres in extent, being 1¼ mile long and ¼ mile wide. The top water is 1000 feet above the sea level, and the water is impounded by a dam 1250 feet long and of a depth of 144 feet from foundation to top bank level; the depth from overflow level to the surface of the rock at the old river course is 100 feet; the rock excavation in the centre of the dam being thus 37 feet deep.

The whole of the gathering ground and the site of the works are on the old red sandstone formation, but the site of the dam was found on examination to contain many minute cracks which had been caused by ice pressure, this being a valley of ice denudation. These cracks had to be followed down and worked out, and this has caused considerable expenditure of time and money, there being nearly 50,000 cubic yards more excavation

in the dam than was contemplated. All these difficulties have now been overcome, and the work is now constructed up to a level of 15 feet below overflow level.

The work was originally let by contract, but on account of slow progress, the Swansea Corporation took the work over, and have since carried it on by direct administration, and during the last two years great progress has been made under the works manager, Mr. B. MacKenzie, over 60,000 cubic yards of concrete having been put in during 12 months.

According to the Author's original design, the Cray dam was to be constructed of rubble masonry in cement mortar with blocking facing from stone obtained from quarries on the ground and being the blue beds of the old red sandstone; but it was soon found that although there was an ample supply of stone on the ground, it was of such irregular shapes that it would be difficult and expensive to dress it for facing blocks, and it would also be expensive to dress it roughly for rubble. Therefore, it was decided at an early stage of the construction to alter the character of the dam by constructing the hearting of cyclopean masonry and substituting blue Staffordshire bricks for the facing thoroughout; this has been done, and the Author is of opinion that a great saving has been made in time and cost in the hearting and the facing. The Author has visited many masonry dams on the Continent, and believes that brick has not before been used as a facing for a masonry dam, with the exception of the water face of the small dam at Remscheid in Germany, and the water face of the submerged dam at Rhayader.

Such a radical change in dam construction was not, therefore, undertaken without careful consideration; but the Author's experiments on the relative water-tightness, durability, and resistance to frost of stone and blue brick, which were carried on over several months, lead him to the conclusion that this facing will be absolutely successful in every way, and it offers undeniable advantages in speed and ease of construction.

The brick facing on both the inner and outer facing is of an average thickness of 18 inches carefully tied into the hearting. All external brickwork is of pressed blue facing bricks, the inner being the best brindled bricks, all set in 3 to 1 cement mortar.

The hearting of the dam consists of large blocks of stone as they come from the quarry, surrounded by Portland cement

concrete, consisting of 5 of crushed sandstone, 2 of sand, and 1 of cement; a richer concrete with no plums, and consisting of 3·4 of crushed stone, 2 of sand, and 1 of cement, is laid all over the base of the dam and up the water face of the dam.

The overflow water from the reservoir will pass over a granite weir crest 200 feet long, and down the back of the dam. This unusual length is provided to meet the violent floods which occur in the valley due to the steepness of the surrounding hills, the water-tightness of the ground, and the very heavy rainfall. A roadway is carried along the top of the dam and crosses along the crest of the overflow in a series of brick arches.

A culvert, 13 feet high and 8 feet wide, is temporarily left through the dam to carry the stream during construction, and this culvert has been nearly filled with water during flood times. On completion of the work a 3-foot cast-iron pipe with a double set of 36-inch valves on the outer end will be built in this discharge tunnel; the stopping at the inner end will be of brick in cement and the remainder of the tunnel will be filled with concrete.

Compensation water to the extent of 1½ million gallons per day will be discharged through the 3-feet pipes into the river Cray for the riparian owners and fishing interests on the rivers Cray and Usk.

The profile of the dam is lighter than is generally adopted, but is ample, the maximum stress being under 8 tons per square foot.

The Cray reservoir not being in the natural drainage area of Swansea, it was necessary to drive a tunnel commencing at the bottom of the reservoir and terminating in the watershed of the river Tawe, which passes down to Swansea. This tunnel is about three miles long, and was principally driven from the south, or Swansea end, and from a working shaft on the reservoir ground, or north end, these points being about 2300 yards apart. The headings met without any difference in level, and within four inches for line, which was very satisfactory, as one heading had to be set out from a short base line transferred down the working shaft in which there was a considerable amount of water dripping. This tunnel is internally 5 feet high and 3 feet 6 inches wide, and is lined with three half-brick rings of brindled Staffordshire bricks in 2 to 1 cement mortar. The water flowing from the reservoir through this tunnel is regulated in a valve-

tower placed at the west side of the reservoir. The valves are placed in it in such positions as to decant water at 20 feet, 50 feet, and 80 feet below overflow level; the upper valves will be 18 inches in diameter, and the lower valves 24 inches in diameter, in duplicate, and are of the design known as roller-bearing valves. These valves are all worked from the valve-house built upon the top of the valve-tower, which is reached by a foot-bridge spanning from the valve-tower to an abutment on the side of the reservoir. After the water passes through the tunnel it emerges in a gauge basin, where screens are to be provided, after passing through which, the water enters into the mains to Swansea. At the present time one main has been laid complete and is 17 inches diameter; it discharges 2,500,000 gallons per day into the service reservoir at Town Hill, which is at an elevation of 580 feet above Ordnance Datum, immediately overlooking the town of Swansea. This main has been designed to stand the full pressure due to the water from the gauge basin; it is 23½ miles long, and on completion there was not a single burst during the testing. The contractors for the pipe line were Sir John Aird and Son, the pipes being supplied by Messrs. D. Y. Stewart and Co., and the valves by Messrs. Glenfield and Kennedy, Ltd. The second line of pipes is now in contemplation and will consist of a 24-inch main, which will deliver to a height of 350 feet above Ordnance Datum into a service reservoir yet to be constructed.

The rainfall in the Cray watershed is remarkable, and the following particulars of the local distribution of rainfall may be of interest.

The prevailing wind at Swansea is south west. In the year June 1899 to June 1900 rain fell on 171 days, and out of these 171 days the wind was about south west for 85 days. Again, taking the year 1903, it rained 223 days, and out of these the wind was between south and west for 112 days.

The south west wind arrives at Swansea having travelled hundreds of miles over the Atlantic Ocean, and is warm, and charged with moisture. This strikes just upon the coast and we have a rainfall of 40 inches at Swansea; the wind continuing up the Swansea Valley; the moist air being pushed forward over rising land, also rises, as it rises it expands, and as it expands it becomes cooler and will no longer hold its moisture; it is also chilled by contact with the cold mountains, and having to pass

over them, the clouds reach their greatest elevation and deposit the greatest rainfall. After this the air cannot pass forward at the same level above the sea, but follows the undulations of the surface, and gradually sinks lower, and the rainfall becomes less. Now, taking the line from Swansea to Cray, we gradually ascend until we reach the Pass or Saddle of the Bwlch, where we have the greatest rainfall, and then arrive at the Cray gathering ground, where the rainfall commences to decrease, and continuing forward arrive at Brecon, which has a rainfall little more than Swansea, although the elevation is much greater; if we continued forward to Hereford, we should find the rainfall only 30 inches.

			Inches.
Commencing at	Swansea,	we have	40
"	Morriston	"	45
"	Ystalyfera	"	62
"	Nantyrwydd	"	75·15
"	Bwlch	"	112·91
"	Cray No. 2	"	75·69
"	Cray No. 1	"	71·78
"	Maescarnog	"	68·11
"	Brecon	"	48·50
"	Hereford	"	30·00

Taking Swansea to Nantyrwydd the increase of rainfall is about 1 inch per annum for every 26 feet gained in elevation.

At the Velindre watershed the increase is 1 inch of rain for every 32 feet of elevation.

The average monthly rainfall at the Lower Lliw reservoir far 33 years is as follows:—

	Inches.
January	5·09
February	3·77
March	3·80
April	3·16
May	2·84
June	3·08
July	4·10
August	4·68
September	5·17
October	6·60
November	5·52
December	5·82

The greatest daily rainfall at Bwlch was 6·67 inches on January 26, 1903; at Velindre 2·54 inches on August 13, 1901; and at Swansea 2·08 inches on October 27, 1903.

Cray, with an altitude of 1000 feet above the sea, has a temperature of 11·5 degrees lower than the temperature of Swansea.

The estimated cost of the Cray works is 566,000*l.*, of which 483,000*l.* has been expended.

Arrangements are being made for putting in the valves this summer.

The Cray works have been designed by the Author, and the consulting engineers for the works are Messrs. G. H. Hill and Sons, Westminster, S.W.

DISCUSSION.

The PRESIDENT: There is one question I should like to ask. You have estimated for an ice pressure of 20 tons to the square foot, as you appear to have assumed ice at 12 in. deep, I presume the ice pressure is also estimated at 20 tons per lineal foot of dam.

Mr. R. H. WYRILL: We found that ice would exert an enormous bursting power. The exact amount we have no information of at the present time. It is believed, from experiments made in America, to be equal to 20 tons per square foot and in some cases to 30 tons. On our old reservoirs we have had 11½ in. of ice. If that were pushing against the side of the dam, you would have to take it into consideration in the stability of the dam. It is not expected that we shall ever have this water frozen. We have within six miles of the reservoir two pools, and they are never frozen over. The only ice we shall have is a little at the tail and sides of the reservoir.

Mr. T. F. HARVEY: I agree with the Author that a large number of gauges are necessary. I think that the substitution of Staffordshire blue brick for dressed stone in the face of the dam must result in a great saving of money.

A hearty vote of thanks was accorded to Mr. Wyrill for his paper.

Mr. WYRILL: I may say that the altitude of the reservoir at Swansea is 618 ft. above the sea level; the altitude of this reservoir is 1000 ft. above the sea level. The average temperature is 11½ degrees lower than the temperature at Swansea.

On Friday, the 14th of July, the President and Members visited and inspected the Swansea Corporation Electricity Works, the Destructor Works, where the Prettyjohn's machine for the making of hollow concrete building blocks was seen at work, and the new police and fire station.

The Members had luncheon together at the Metropole Hotel, the President (Mr. A. E. Collins) in the chair.

In the afternoon a tour was made of the tramway system of the Borough in cars specially provided by the Tramway Company. A visit was then made to the Works of the Mannesmann Tube Company. The whole of the processes of manufacture of weldless steel spigot and faucet tubes were followed with much interest. On returning to the Guildhall the papers of Mr. G. Bell and Mr. C. A. L. Prusmann were discussed. At the conclusion of the discussion, the Mayor (Alderman W. H. Spring) entertained the members to tea, and later a visit was made to the Mumbles in special cars provided by the Swansea and Mumbles Railway and Pier Company.

On Saturday, the 15th of July, the Members travelled by special train to Cray to inspect the new reservoir and dam which are being constructed there for the Swansea Corporation. On arrival the party were taken on board a contractor's train over the extensive works which are in progress. The Members were then entertained to luncheon, the Mayor (Alderman W. H. Spring) presiding, after which Mr. Wyrill's paper was presented and discussed.

SCOTTISH DISTRICT MEETING.

August 26, 1905.

Held in the Town Hall, Ayr.

A. E. COLLINS, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Provost (Mr. W. Allan) received the Members, and offered them a hearty welcome to Ayr.

The President, on behalf of the Association, thanked the Provost for the kind welcome he had given them.

Mr. J. Bryce was unanimously re-elected Hon. Secretary for the Scottish District.

SCOTTISH BY-LAWS COMMITTEE.

Mr. J. BRYCE: The Committee appointed at Glasgow to revise the Scottish by-laws have made considerable progress in their work. We have had several meetings on the subject, and as those Scottish Members who know the provisions of the Burgh Police (Scotland) Act of 1903 are aware, thirteen distinct sections of by-laws have to be prepared. It is perfectly impossible to complete our work in one year. Drafts have been prepared in connection with the following sections: buildings, house drainage, streets and footways, light and ventilation, division walls, fences and boundaries, and the inspection of house drainage. The work still to be done, is fire prevention and means of escape, scaffolds, barricades, hoardings, public stands and platforms. Then, when we have these drafts prepared, we have got the whole of the work of revision. That will be a considerable work in itself, and it is difficult to state a date when it will be completed, because there will be the individual revision of each draft, and then there will be the collective revision of the by-laws as a whole. I should not

forget to say that the work, and cost of the whole thing, will be far more than we anticipated. And I would like to throw out this suggestion, that the Scottish burghs should contribute to the expense of this work, because it is really work they should do. We are doing it for them, and when we have got it done, we shall be able to say to the burghs of Scotland, "here is a set of by-laws you can adopt." It seems to me that we ought to decide to-day that some kind of circular should be sent to the burghs in Scotland asking them to contribute to the cost of doing this work, which will be considerable. We cannot expect Members to come and spend two and three days at a time revising these by-laws which are for the use and benefit of the authorities, unless some of their expenses are paid.

Mr. F. G. Holmes: I have very much pleasure in seconding Mr. Bryce's proposal that circulars be issued asking the Scottish burgh Councils to contribute to the cost of the preparation of by-laws for their use. By the 1903 Act, the Town Councils of the various burghs have to prepare these by-laws, and I think it will be much better if the surveyors put their heads together and frame by-laws that will be acceptable to the whole of the burghs. The system of the various burghs working under different by-laws is very inconvenient with reference to buildings, drainage, and other matters. Plumbers working in one burgh have to work under certain by-laws, and when they go to work in another burgh, possibly not more than half a mile away, they have to work under different by-laws, which is very inconvenient. Therefore uniformity of by-laws in all the burghs would be a great advantage. The contribution would be quite a fair charge against the burghs, because if they prepare separate by-laws, the cost would, in all probability, be much greater.

The President: I quite agree with the proposition which has been submitted to the meeting. In England we have experienced exactly the same thing in connection with building by-laws. Great expense has been incurred, as you are incurring expense in Scotland, and having regard to the fact that the benefits accruing are reaped entirely by the local authorities, they ought to assist financially.

The proposition was unanimously carried.

The President then welcomed and introduced M. Van Lint, Waterworks Engineer of Brussels, to the meeting.

The President said: We are all exceedingly pleased to have

M. Van Lint with us this morning. It is a continuation of the efforts which have been made to establish the *entente cordiale* between this country and our Continental friends. The establishment of this proposed Association of Municipal Engineers in the French-speaking countries will also have the effect of unifying the practice of municipal engineering in those countries. That will be of benefit all round, and will insure the public getting the best value in health and other ways for the money they expend. We are very pleased to welcome M. Van Lint here to-day, and we hope there will be most friendly relations between our own Association and this new association which is about to be formed.

M. Van Lint said: It is with great pleasure that I avail myself of the opportunity afforded me, to greet you and your powerful Association. It is not altogether in a private or individual capacity that I address you to day, but rather as the representative and one of the founders of the new and promising association that is in course of organisation amongst municipal engineers of French-speaking countries—France, Belgium, Switzerland, and the Luxembourg.

Your own Association, gentlemen, is a growth of many years, and your organisation permits you to come into mutual contact several times a year, thus permitting an almost continuous exchange of ideas. It is the lack of any organised society of the kind in French-speaking countries that has debarred your colleagues across the channel from participating in that exchange of ideas that has given such a healthy fillip to the development of British knowledge in matters hygienic. Up to the present, your French-speaking confrères have worked independently of one another, without any organised medium to serve as a channel for ventilating and discussing their ideas. As a result it has not been rare to find hygienists and hydraulic engineers at loggerheads. We are now, however, taking pattern by the example afforded us by the successful associations of our English, American, and German brothers, and our organisation has already received the support of a large number of medical officers and officials of government and other public departments. Municipal officers are assisting the association by every means in their power, and Monsieur Casimir Périer, former President of the French Republic, has been pleased to accept the Honorary Presidency.

Our funds are in a state of healthy development, and our bank account already boasts of a credit of some few thousand francs. We are at present busily engaged in the work of organisation, and I take advantage of the present occasion to invite you to assist at our first Congress, which is to be held in Paris in November next.

We shall be only too pleased to enrol corresponding members, and any engineer may join the association. Corresponding members, apart from the right of voting, enjoy all the privileges of ordinary members, and in addition to assisting at our annual congresses and excursions, they will be entitled to receive regularly the official technical journal of the association—the "Technique Sanitaire," which will prove most interesting to them. On the other hand, they can obtain, on application to our technical bureau, information on any technical subject in which they are interested. We hope to secure for the members taking part in our congress, the usual travelling facilities of half-fare tickets, and will otherwise do all in our power to make their stay in Paris a pleasant one.

In taking leave of you now, it remains for me to express the hope that our future relations will be of a friendly nature, based on the strong foundations of mutual kindred interests, and that by our co-operation we shall march ahead together with the common object of the protection of health and the prolongation of human life.

SOME OF THE MUNICIPAL WORKS OF AYR

By JOHN YOUNG, Town Surveyor, Water and Tramway Engineer, Ayr.

History and Statistics of the Burgh.

The town of Ayr was created a Royal Burgh by Charter of William the Lion about 1202.

From the earliest times Ayr was of importance as a port, a military centre, and a place of commercial activity. The history of the town and surrounding district is rich in historical, antiquarian and literary associations, of which its inhabitants are justly proud. Its connection with Robert Burns has gained for it a world-wide notice, and yearly it is the resort of large numbers of tourists and visitors from many lands.

Ayr proper is situated on the south bank of the river Ayr, Newton-on-Ayr and Wallacetown are situated on the north bank, and were separate communities until 1873, when the municipal boundaries were extended by the Ayr Burgh Act, 1873, to include Newton and Wallacetown. The boundaries of the burgh were further extended by the Ayr Burgh Act of 1885, when a large addition was made to the area of the town, which now extends to 2001 acres.

Ayr stretches, for a distance of about three miles, along a beautiful bay of the Firth of Clyde, flanked on the south by the Carrick Hills, with the Cumnock Hills to the east. The subsoil is generally sand for a considerable depth, with occasional areas of surface clays, both overlying the measures of the Ayrshire coalfield, which outcrop in the bed of the river Ayr. The river Ayr passes through the town from east to west, has an average breadth of 250 feet, and is tidal for a distance of three-quarters of a mile within the burgh. The tide rises about 9 feet at the old bridge. The river Ayr drains a large tract of country, and considerable volumes of water are discharged, particularly during

heavy floods, when the level at high water may be raised by 4 feet above the normal. The last great flood was in November 1904.

The burgh has a gentle slope towards the sea, the minimum and maximum levels being 10 feet O.D. and 62 feet O.D. respectively. The population of Ayr, Newton, and Wallacetown amounted at 1901 census to 28,697. At the present time it is about 30,100. The gross valuation of the burgh is about 197,000*l.*

Ayr, and vicinity, has for a long number of years been a popular holiday resort. The population is occasionally increased by anything from 1000 to 8000 excursionists in one day during the summer months. The climate of the town is very mild and healthy. The death rate for last year was 18 per 1000. The rainfall is about 38 inches per annum.

Roads and Bridges.

The public highways and streets extend to 37 miles, of which 9 miles are main thoroughfares, classed as follows:—

Streets paved with granite or whinstone setts and cubes and Walker and Sons' tar macadam	5·5 miles.
Macadamised streets	31·5 "
	37·0

The net cost of maintenance only of the roads for the year ending May 1904, was 3288*l.*, or about 89*l.* per mile of the whole streets, paved and macadamised, within the burgh.

The paved streets are constructed with a 6-inch thick cement concrete bed, 1-inch sand cushion, and 3½-inch to 4-inch by 6-inch or 7-inch deep whinstone setts from the Ayrshire quarries, or with 4 inch by 4-inch granite cubes 5 inches deep, grouted with Portland cement and sand, 1 to 3, or bituminous pitch and kiln-dried stone chips. The tar macadam laid in the town is by the firm of W. G. Walker and Sons, of Ayr. This material is laid in three coats of graded sizes directly on the top of an ordinary macadamised road and thoroughly rolled down, after an application of each coat of the specially prepared materials. The cost of 4-inch thick tar macadam is 4*s.* 6*d.* per superficial yard, the firm giving a guaranteed upkeep for ten years, with the first two years' free upkeep, and at the rate of 3*d.* per square yard, per annum, for the next eight years. This works out at a

total cost of 6·6*d.* per square yard for the ten years, or about 7·8*d.* per square yard, per annum. This class of paving is very suitable for light and moderately heavy traffic. It is rapidly laid, with very little inconvenience to traffic, is practically noiseless, impervious, and easily cleaned and kept in good order. Like all smooth paving, it requires to be sanded during frost, but not to the same extent as asphalt. In a recent report on the paving of streets in the burgh the Author had occasion to go very carefully into the initial cost and annual cost, per square yard, of different classes of paving, with the following results, viz.:—

TABLE OF COMPARATIVE COST OF DIFFERENT CLASSES OF STREET PAVING.

Description of Paving.	First cost of Construction per sq. yard. *s.* *d.*	Cost of Construction and Maintenance during various periods, per square yard per annum.
1. Ordinary macadamising with 8-inch thick foundation and machine-broken metal.	3 6	Cost quoted for comparison only.
Ditto, hand-broken metal	4 0	Ditto.
2. Tar macadam (Walker's)	5 0	*7·8*d.* for 10 years. 6·9*d.* for 20 years.
Ditto, with foundation	6 6	*10·8*d.* for 10 years. 7·8*d.* for 20 years.
3. National asphalt slab paving on concrete foundation	10 0	*1*s.* 2·4*d.* for 10 years. 1*s.* 0·6*d.* for 20 years.
4. Compressed asphalt on foundation	16 0	1*s.* 4*d.* for 12 years.
5. Wood paving (Blackbutt) on foundation ..	16 0	*1*s.* 6*d.* for 12 years.
6. Whinstone setts on foundation	11 0	*6·6*d.* for 10 years. 8·4*d.* for 20 years.
7. Whinstone cubes on foundation	8 6	6·8*d.* for 15 years.

* These figures include for maintenance and partial or entire relaying of the paving during the various periods stated.

The private streets are formed in accordance with a standard specification adopted by the Corporation. Where these streets are not made up by the frontagers, the Corporation does the work under the powers given by the Burgh Police (Scotland) Acts, 1892 and 1903. Part II. of the 1903 Act has been

adopted in the burgh, and the width of streets must now be 60 feet between buildings, with 40 feet set apart for carriageway and footpaths.

New streets are formed by laying down a foundation of stones 8 inches deep hand set on edge. The interstices of the stones are pinned and wedged up and blinded with shivers and thoroughly rolled with the steam roller to the cross section; 2½-inch hand broken blue whinstone metal from Parkthorn Quarry is then laid over the road and hard rolled in until the thickness is 4 inches. After the metal has been well set and rolling has no further impression on it, a coating of clean coarse gritty sand is spread over the metalling, and watering, grouting, brushing and rolling are continued until a hard smooth surface is obtained. After this work is finished a good coating of whinstone chips, from the stonebreaker, is spread over the road, as it is found that this prevents the loose stones from rising, and in process of time the chips work into the interstices of the metalling and make a very smooth surface.

The kerbing laid is of whinstone or Irish granite, 6 inches by 12 inches if laid on edge, and 12 inches by 8 inches if laid on flat. The water channels are set on 6 inches of bottoming, and formed with whinstone setts, 21 inches broad, having the joints at right angles to the kerbing, and grouted with Portland cement and sand 1 to 3. Portland cement concrete water channels 14 inches broad by 7½ inches deep, having a 1½-inch deep hollowed upper surface, faced 1½ inches thick on top with granolithic, have also been largely used. These are laid on 6 inches of bottoming in 9 feet lengths *in situ*, and make a most satisfactory water channel. The gullies are of strong glazed fire-clay, 18 inches diameter, and 27 inches deep, with trap and cleaning eye all in one piece, kept well up to the top so as to leave good space for the interception of road grit. The gratings are of the usual movable cast-iron pattern, in frames bedded to the top of the gullies. The cost of forming a 24-foot macadamised carriageway, with causewayed water channels, and 6 inch by 12 inch granite kerbing, including gullies, branch drains, and all other incidental work, is 7*s*. per lineal foot of frontage. If formed with concrete water channels, the cost is 6*s*. 3*d*. per lineal foot of frontage. It may also be stated that the Corporation charge 5 per cent. for engineering expenses, and 1½ per cent. for collection on the total cost of private street works.

Footways of public and private streets are made up with Arbroath and Caithness flagging, Portland cement concrete and Messrs. Walker and Sons' tar macadam, the cost being 9*s.*, 3*s.* 8*d.*, and 2*s.* 6*d.* (2*s.* 4*d.* if over 100 square yards) per square yard respectively. The main thoroughfares are mostly of flagging and concrete. In the side and suburban streets tar macadam is extensively employed in the making of the footpaths. When this paving becomes worn through the upper coat, it can be recoated at a cost of 1*s.* 3*d.* per square yard, and where only slightly worn it is tarred and dusted with dried limestone at a cost of 3*d.* per square yard. This work can be rapidly executed without interfering with foot traffic.

The Author has gone somewhat into detail in regard to the cost of formation of private streets and footways, so that the Members may give comparative figures for the relative costs of these works in their own burghs.

Bridges.

The river Ayr is spanned by six bridges within a distance of three-quarters of a mile. The principal road-traffic bridge is the New Bridge, built in 1879 to replace the former bridge, erected in 1788. It is 88 yards in length by 50 feet in width, and constructed with red sandstone piers and spandril walls, and granite arches and parapets. There are five spans, of 43 feet to 48 feet each. The bridge is of very heavy proportions, massive in design, and cost 15,000*l.* The engineers were Messrs. Blyth and Cunningham. The Victoria Bridge, opened in 1898, was designed and carried out by Mr. John Eaglesham, late town surveyor, at a cost of 9500*l.* It is 70 yards long and 38 feet wide. It consists of sandstone piers, with three steel arched-rib spans supporting a steel trough-decking for the roadway. The spandrils and parapets are of ornamental design, in cast-iron work. The roadway and footpaths of this bridge are formed with Walker's tar macadam, with granite kerbings. Two bridges carry the railway traffic; the one at the harbour, being for goods only, is of steel construction, and the other to the passenger station is a stone structure of great strength. This latter bridge has a narrow footbridge overhung on the west side.

Of the two footbridges, Turner's bridge is a light and elegant steel structure, also on the arched-rib principle—gifted to the

town by A. M. Turner, Esq., of Ayr, and erected by him from the designs of Messrs. J. and H. V. Eaglesham, C.E., Ayr, at a cost of about 3000*l*. The other footbridge is the Auld Brig of Ayr, which has recently had a large degree of attention drawn to it from all parts of the world on account of the proposal to take down and rebuild it. The history, historical and literary associations of the Auld Brig, together with the peculiarities in its construction, and a description of its defects, would require a paper of itself. Originally erected in the fifteenth century, it is a splendid example of the constructive skill of the period. It now presents a structure of venerable charm and unique value from an antiquarian standpoint. It has been immortalised in Burns's poem, "The Brigs of Ayr." The Town Council found it necessary, acting on the advice of Mr. B. Hall Blyth, M.Inst.C.E., to close the bridge temporarily last summer, and the Author was instructed to put in timber centering and supports, to obviate any risks of a sudden collapse. This work, as well as the condition of the bridge, the Members will have an opportunity of examining for themselves. Many years ago Mr. Templeton, watchmaker, Ayr, left the whole of his estate—at the expiry of certain life-rents—for the rebuilding of the bridge. The amount available for this purpose is about 11,000*l*. The Town Council, after very careful consideration of detailed reports from Mr. James A. Morris, F.R.I.B.A., architect, Ayr, Mr. John Eaglesham, C.E., and the town surveyor, submitted these to the final examination of Mr. B. Hall Blyth, M.Inst.C.E., and Sir William Arrol, M.P. Acting on the recommendations of these gentlemen, who—with the exception of Mr. Morris—were in favour of rebuilding the bridge, the Author is presently preparing plans and specifications for the taking down and rebuilding of the bridge. The main idea is to produce an exact replica of the old bridge, using the present materials—as far as they can be introduced in the new structure—in the same situation as they formerly were in the original bridge. This task is no light one, as the exact position of every stone in the bridge will have to be ascertained, and great care exercised in replacing it in its proper position. The foundations of the piers, which rest on oak cradles, are presently several feet above the river bed, and new foundations will be put in at a depth of about 8 feet lower. It is proposed to utilise the present centering in the reconstruction of the bridge. A temporary foot-

bridge will be constructed for the convenience of the public during the rebuilding.

Street Lighting.

The streets are lighted by 120 electric arc lamps, 174 electric incandescent lamps, and 290 gas lamps. The cost of the arc lamps of 2000-c.p. is 27*l.* per annum, of the 16-c.p. incandescent electric lamps 2*l.* 10*s.* per annum, and of the ordinary 3½ cubic feet per hour gas lamps 39*s.* each per annum, which includes renewal of carbons, burners, globes, lamps, trimming, lighting, and extinguishing. The electric energy is supplied from the Corporation electricity works. The price paid for electric current for lighting is 2*d.* per unit and that for gas is 3*s.* 4*d.* per 1000 cubic feet. The lighting hours per annum are 3050. No lamps are lighted for two months in the summer, with the exception of a few arc and gas lamps at important centres in the town. The total cost per annum for street lighting in Ayr is 5059*l.* With the view of testing the advantages of incandescent gas lighting, three streets have been recently fitted up with Welsbach and other types of lamps. The results are being carefully tested and records kept for comparison.

Refuse Disposal Works.

The work of scavenging, cleansing, and refuse collection is done by the Sanitary Department, under the charge of Mr. R. Adam, Inspector of Cleansing. The street sweepings and house refuse were formerly tipped into a quarry within the burgh, but on this being filled up about two years ago other means of disposal had to be found. As no places, within a reasonable distance of the burgh, could be obtained, the Town Council decided, after careful inquiry, to erect a destructor on a site adjoining the Corporation electricity works in Mill Street. The site of the works, although very limited in area, is very central and lowlying, which permits of the carting being all down hill. It further adjoins the electricity works, where the steam raised by the destructor boiler is utilised. The buildings are of a plain and substantial character arranged in two levels, the lower being the furnace floor level and the upper being the tipping platform level, which is practically at the same level as the adjoining

street, and is connected therewith by a bridged roadway. On the lower, or furnace, floor a Meldrum's "Simplex" Regenerative Refuse Destructor of six grates, arranged in one unit of four grates and one unit of two grates, with space left for extension to four grates. The grates have an area of 25 square feet each, and can consume 12 tons of refuse per 24 hours. The furnaces are in continuous grates, but the ashpits below have division walls for the purpose of regulating the forced draught to each grate as desired. Under the ashpits are the flues for the hot air used in combustion, which is sucked into the ashpit space and forced under the fire grates by Meldrum's patent forced draught apparatus, consisting of steam jets and trumpet mouthed blowers —two to each ashpit. The waste gases after passing the boiler are passed through a stack of pipes known as the regenerator. As the whole of the air for combustion must pass around the highly heated pipes it arrives at the blowers considerably increased in temperature. This aids greatly in the combustion of the refuse and the promotion of flame in the furnaces. Between the two units of the destructor grates are placed main flues, both leading meantime to the boiler, also a by-pass flue direct to the chimney for use when the boiler is not working. The boiler is of the Babcock and Wilcox water tube type, and has a heating surface of 2852 square feet and a working pressure of 200 lb. per square inch. The main steam pipe is 7 inches in diameter, and is connected to the main pipe in the electricity works through a reducing valve so as to deliver the steam at 140 lb. constant pressure. The boiler setting is provided with ample dust pits and several access manholes for the cleaning. The dampers in the main flues are of fire-bricks set into cast-iron frames, and are operated by windlass gearing. The whole of the destructor furnaces, flues and boiler setting are very strongly built and bound together by an elaborate system of channel-iron stays and tie-bars. The furnaces, etc., are faced outside with pressed red facing bricks and lined throughout with the best Glenboig firebricks. The linings of walls and arches are set on cast-iron lintels and skewbacks, so that they can be repaired without disturbing the other brickwork.

The refuse is tipped directly from the carts into two large hoppers in the tipping platform above. It falls down on to the shovelling sills on the furnace floor level, and is thrown into the furnace by hand shovelling on the front feed principle.

After remaining on the furnace from $1\frac{1}{2}$ to 2 hours—during which time the refuse is broken up and new applications of refuse added—it is allowed to burn off and clinker into a large caked mass, which is then broken up with slicing bars, drawn out of the furnace into a wheelbarrow, and deposited in the yard to cool. An overhead railway running along the front of the furnaces and thence to the yard, with side-tipping buckets, has been provided for the removal of the hot clinker. The workmen, however, prefer to use wheelbarrows for this work. A "Berryman" feed-water heater, "Worthington" horizontal feed pump, cast-iron water storage tank of 1000 gallons capacity, and water meter, with the necessary duplicate supply and delivery piping, valves, injector, etc., have been provided in connection with the boiler. An auxiliary pump has also been provided for utilising the river water for boiler feeding at a future time.

Special attention may be directed to the chimney, which is built on the "Alphons Custodis" principle. The height is 120 feet from ground level, with square pedestal and circular shaft, 8 feet diameter at base, and 5 feet 6 inches diameter at top internally. The circular shaft is built with specially made radiated bricks, perforated with holes through the beds. The chimney is lined from bottom to top with 4-inch thick fire bricks, leaving a $1\frac{1}{2}$ inch space between lining and outer wall. The lining is carried on corbels projecting from the outer wall, and is built in stages of 16 feet each in height, with a space left for expansion at the top of each stage. This method of construction permits of the internal lining being renewed at any height without disturbing the work above, as would be the case with an independent inside chimney lining. It is further claimed that there is greater economy in materials, a larger area obtained, and additional stability given to the chimney wall.

The clinker crushing plant consists of a breaker, bucket, elevator, and inclined revolving screens. The capacity of the plant is guaranteed at 3 tons of clinker crushed and screened per hour, the sizes made being $\frac{3}{16}$ inch, $\frac{1}{2}$ inch, and 1 inch from the 3 screens, and "tailings" from 2 inches to $2\frac{1}{2}$ inches from the end of the screen. With the exception of the fine stuff and dust which comes through the $\frac{3}{16}$ inch screen, the material is very clean, and has a ready sale in the town. The price obtained is 1*s.* 6*d.* per ton at the works.

From a test made, the proportions of the different sizes are as follows:—

	tons	cwt.	qrs.
$\frac{3}{16}$-inch screen	0	18	2
½-inch "	3	19	3
1-inch "	2	10	0
"Tailings" from 2 inches to 2½ inches	3	13	0
Total..	11	1	1

An 8-feet diameter mortar mill and gearing has been provided, in which the crushed clinker and lime are ground up together, producing a very strong mortar. Very little demand for the mortar has yet been made by builders. The clinker crushing plant and mortar mill, with the shafting and gearing in connection, are driven by a 25 E.H.P. motor by Bruce Peebles and Co., the electrical energy being obtained from the electricity works.

The only other buildings in connection with the destructor are the motor room, lime shed, the covered-in clinker yard, and the office and weighing machine at the entrance to the works.

Mention may also be made of the men's mess room, dressing-room, bath-room and lavatories, in a separate building at one side of the yard. This has proved a very useful adjunct, being much appreciated by the workmen.

The destructor is worked sixteen hours per day, in shifts of eight hours each, and for six days in the week. Every alternate Sunday the flues are cleaned and the plant overhauled. The staff consists of two foremen (who also act as boiler attendants in shifts), six stokers, one man for clinker crushing, and one clerk. The average cost of consuming the refuse is 1*s.* 1*d.* per ton, which includes labour and tools.

The amount of house, shop, and other miscellaneous refuse received at the destructor works in Ayr averages about thirty-two tons per day.

A test of the destructor plant under the ordinary working conditions is shown on pp. 86 and 87.

The cost of the works is as follows:—

	£
Buildings	4,450
Destructor, plant and machinery	5,598
Chimney	706
Total	£10,754

BURGH OF AYR.

DESTRUCTOR TEST. MAY 27, 1904.

TYPE OF PLANT ..	Meldrum's Patent Hand-Fed Simplex Regenerative Refuse Destructor	—
	No. of cells, 4; area, 25 sq. ft. each .. .. Total grate area =	100 sq. ft.
	Type of boiler, Babcock and Wilcox	2852 ft. heating surface.
	Duration of test	16 hours.
	Time of test	12 A.M. to 4 P.M.
CLASS OF REFUSE	Household and garden refuse	—
	Total refuse delivered, including pots, tins, etc.	40 ton 11 cwt. 1 qr. 14 lb. = 90,871 lb.
	Weight of pots, tins, etc.	11 cwt. 2 qr. = 1288 lb.
	Proportion of pots, tins, etc.	1·4 per cent.
	Weight of refuse per hour, deducting pots, tins, etc.	5598·93 lb.
	" " consumed per sq. ft. of grate per hour	55·98 lb.
	" " per cell per 16 hours	22,716·7 lb.
	" " " per hour	1419·8 lb.
RESIDUALS	" clinker drawn from fire grates	9 ton 15 cwt. 0 qr. 2 lb. = 21,842 lb.
	" flue dust	8 cwt. 3 qr. = 980 lb.
	" fused dust from combustion chamber	3 cwt. 0 qr. 16 lb. = 352 lb.
	" ashes from ashpits	1 ton 1 cwt. 3 qr. 12 lb. = 2448 lb.
	Proportion of clinker	24·03 per cent
	" dust, ashes, etc.	3·9 "
	" residuals .. .. Total	27·93 "
ASHPIT PRESSURES	Ashpit pressure in inches of water .. .. Highest	2·25 inches.
	" " " " .. .. Lowest	·75 "
	" " " " .. .. Average	1·75 "
STEAM PRESSURE ..	Steam pressure .. .. Highest	200 lb.
	" " .. .. Lowest	85 lb.
	" " .. .. Average	143·4 lb.
WATER	Total water evaporated during test	11,840 gallons = 118,400 lb.
	" " per hour .. .. Actual	7400 lb.
	" " per sq. ft. of heating surface per hour .. .. "	2·5 lb.
	" " per lb. of refuse consumed	1·32 lb.

Horse Power	I.H.P. per hour, allowing 20 lb. of steam per I.H.P.		870.
Temperatures	Temperature of air before regenerator	Highest	68° F.
	" " " "	Lowest	45° F.
	" " " "	Average	55·9° F.
	" " to furnace ashpits	Highest	270° F.
	" " " "	Lowest	225° F.
	" " " "	Average	244·4° F.
	" of gases in combustion chamber	Highest	2462° F.
	" " " "	Lowest	1764° F.
	" " " "	Average	1965·3° F.
	" " leaving boiler	Highest	600° F.
	" " "	Lowest	400° F.
	" " "	Average	541·8° F.
	" " at chimney base	Highest	570° F.
	" " " "	Lowest	325° F.
	" " " "	Average	497·5° F.
Vacua	Vacuum at chimney base in inches of water	Highest	·875 inches.
	" " " "	Lowest	·5 "
	" " " "	Average	·711 "
	" before regenerator	Highest	·687 "
	" " "	Lowest	·5 "
	" " "	Average	·645 "
Gas Analysis	CO_2	Highest	11·8 per cent.
	"	Lowest	5·4 "
	"	Average	9·17 "
	O	Highest	15·5 "
	"	Lowest	8·5 "
	"	Average	12·3 "
	CO	Highest	·3 "
	"	Lowest	·0 "
	"	Average	·171 "

Waterworks.

The original waterworks of Ayr were constructed in 1855, and acquired by the Corporation from the Ayr Water Company under the Ayr Corporation Act of 1873. This supply was derived principally from springs on the Milton and Grange farms, about 8 miles to the south of Ayr. The spring-water was impounded in two reservoirs at Carcluie, about 5 miles from Ayr. In 1885 the Corporation found it necessary to obtain parliamentary powers for additional water supply, and were successful in bringing into the burgh, in 1887, the present supply from Loch Finlas, which is distant about 25 miles from Ayr, and at an elevation of 850 feet above sea-level. By the construction of a low embankment and waste weir at Loch Finlas, a storage capacity, when full, of 347,000,000 gallons has been obtained. The supply is brought from the loch to the filters at Knockjarder, a distance of 19 miles, by 18-inch diameter fire-clay pipes for a distance of 2 miles, and thereafter by a cast-iron main supply pipe 16 inches, 15 inches, and 14 inches in diameter, mostly laid along the public roads. The water is filtered by six open sand filters, and stored in two clear water tanks at Knockjarder filter works, about 5 miles to the south of Ayr, and at an elevation of 290 feet O.D., which is the initial head of water on the town mains. On account of the expansion of the water district, the great growth of building within the burgh, and the extensive introduction of sanitary appliances into the houses, the water supply became taxed to its utmost limits.

In August 1899, the Corporation obtained powers under the Ayr Burgh Act, 1899, to supplement the water supply to the burgh and district by the pumping of the water in the Carcluie reservoirs to Knockjarder, and the construction of a service reservoir there, together with all other necessary works.

Extension of Water Supply.

Under this scheme the old waterworks at Milton, Grange, and Carcluie, belonging to the Corporation—which have practically been out of use for 17 years—are now utilised.

The water presently discharging into the Carcluie reservoirs

comes from the springs and "St. Helen's Well" on Milton Farm. No water is meantime taken from the reservoir or springs on Grange Farm.

The storage capacity of the reservoirs at Carcluie is as follows:—

Carcluie reservoir No. 1	13,000,000	gallons.
" " No. 2	21,000,000	"
Total storage capacity	34,000,000	"

The water to be pumped is mostly taken from Carcluie reservoir No. 2.

The eastern embankment of this reservoir has been reconstructed, and the slope repitched with stone.

The two reservoirs have been connected by forming a junction between the two original outlet pipes. This allows of the upper 10½ feet of water (amounting to about 7 million gallons) of reservoir No. 1 being run into reservoir No. 2. The total quantity available for pumping to Knockjarder is thus:—

From Carcluie reservoir No. 2	18,000,000	gallons.
" " No. 1	7,000,000	"
Total available for pumping	25,000,000	"

Supposing both reservoirs to be full, and no water allowed to enter them, it will take the pumping machinery 33 working days, of 10 hours each, to empty the reservoirs down to the level of the outlet pipe.

The water is conveyed from Carcluie reservoir No. 2 to the well at the pumping station by a 2-feet diameter conduit, 313 yards in length, partly formed of fireclay pipes encased in concrete and partly of cast-iron pipes.

The pump well, situated immediately outside the engine room of the pumping station, and constructed of steel, is 5 feet in diameter and 22 feet 6 inches deep. The water in the pump well is regulated to stand at the same level as that in the reservoir.

The pumping station occupies a triangular piece of ground adjoining the railway, and comprises an engine-room (50 feet by 23 feet) and a boiler-house, coal-store and workshop (34 feet by 19 feet). Space has been left for the addition of another boiler. The chimney is 3 feet 6 inches in diameter inside aud 90 feet in height.

The boiler is of the Babcock and Wilcox water tube type, having 735 square feet of heating surface, and capable of evaporating 2200 lb. of water per hour into steam at a pressure of 100 lb. per square inch. A Holden and Brook's water injector and a Worthington steam pump feed the water into the boiler from the tank, which contains 2000 gallons.

The steam engines and pumps are 35 feet long and 11 feet broad, measured over the bed plates.

The engines are of the horizontal, cross compound, surface condensing type. The cylinders are set parallel, with the pumps behind, and the shafts directly coupled thereto. The main cranks are set at right angles, and the working stroke is 3 feet. The engines and pumps are so arranged that either side of the engine can be worked independently, also condensing or non-condensing. The valve gearing is of the Meyer adjustable cut-off type, and the Pickering governor is driven by double belts off the main shaft. The Edwards air pump is operated by a bell crank from the high pressure crosshead. The condenser is 7 feet 8 inches long and 2 feet 6 inches in diameter, and contains 85 one-inch brass tubes. The pumped water passes through the condenser.

The two horizontal, double-acting pumps are 10½ inches in diameter, with a working stroke of 3 feet, and are brass-lined throughout. The suction and delivery valves are of gun metal, double-lift, annular ring type.

The 16-inch diameter main suction pipe is fitted with a foot valve, strainer, and charging pipe.

The delivery pipe conveying the water to the new reservoir at Knockjarder is 16 inches in diameter and 1480 yards in length. It is fitted with an air vessel, relief, reflux, and stop-valves, emptying-pipe, etc.

The dimensions of the principal parts of the engines and pumping machinery are as follows:—

Steam pressure—100 lb. per square inch.
High-pressure cylinder—15 inches diameter.
Low-pressure cylinder—26 inches diameter.
Working stroke—3 feet.
Speed (maximum)—35 revolutions per minute.
Fly-wheel—12 feet diameter; weight 7 tons.
Main suction pipe—16 inches diameter.
Main delivery pipe—16 inches diameter.
Branch suction and delivery pipes at pumps—10 inches diameter.
Air vessel—9 feet high, 2 feet diameter.
Edwards air pump—12 inches diameter, 15-inch stroke.

The engine and pumping machinery is rated for lifting 19 feet and delivering, in 10 hours, 750,000 gallons of water raised 170 feet and discharged into the gauge well at the new service reservoir at Knockjarder.

The following are the relative levels above O.D. of the Carcluie reservoirs, pumping station, and new service reservoir at Knockjarder:—

	O.D.
Top water level of Carcluie reservoir, No. 1	145·0 feet.
" " " No. 2	154·5 "
Level of outlet pipe to pump well..	134·5 "
Level of bottom of pump well	132·5 "
Engine room, floor level	157·0 "
Level of gauge plate at new service reservoir at Knockjarder	313·5 "
Top water level of ditto	312·5 "
Level of bottom of ditto (average)..	296·5 "
Level of cope of filters	291·5 "

The two cottages adjoining the pumping station, each containing 3 rooms, scullery, washing-house and other conveniences, are occupied by the engineer and the water inspector of the district.

New Service Reservoir at Knockjarder.

The construction of a service reservoir at Knockjarder has long been found necessary, as the main source of water supply (Loch Finlas) is about 17 miles distant. The new reservoir will store 3 days' supply for the burgh and district, and obviate all risk to consumers through accident to the piping from the loch.

The service reservoir is 300 feet in diameter, and averages 17 feet 6 inches deep, and contains, when full, about 7 million gallons. It is divided in the centre by a cross wall 10 feet high, which enables the reservoir to be periodically cleaned out and still retain one day's supply on hand. The floor of the reservoir is of cement concrete, and the walls are of brick in cement faced with brown glazed bricks. The wall is finished with stone coping and iron railing. The floor and walls are made watertight by a thick layer of clay puddle. Embankments have been formed round the reservoir with the material excavated from the site of same. The reservoir site and adjacent ground, extending to about 5 acres, is enclosed with a stone wall and steel pale fencing.

The water supply to the service reservoir enters two inlet wells situated at the south side. Loch Finlas water is discharged into one of the wells, and the pumped water from Carcluie into the other. These waters pass over 3 feet gauge-plates for measurement—the quantities being registered by automatic indicators. After leaving the inlet wells, the waters fall into a mixing chamber, and finally run into the reservoir. Sluices are provided for diverting the flow into either division of the tank.

The water from Loch Finlas is very soft, brown in colour, and contains peaty and suspended matter. Carcluie water is moderately hard, derived from springs, and consequently very clear. The mixture of the two waters, subsidence of the peaty and suspended matter, and aëration in the service reservoir, have a beneficial effect, and render the subsequent filtration more rapid and effectual. The water is drawn off through 2 floating arm pipes, which decant the water 6 inches below the surface, thus ensuring only the purest water being passed on to the filters.

The water is conveyed to the 6 filters, or to the 2 clear-water tanks, by 2 cast-iron pipes, partly 16 inches and partly 12 inches in diameter. These pipes are controlled by valves at the outlet well, which is also provided with overflow weirs and a drain 18 inches in diameter.

A new screening apparatus has been fitted up in the pressure regulating well. The main supply pipes have also been fitted with by-pass pipes so as to allow of this well being emptied for cleaning and repairs.

A new main water supply pipe about 5¼ miles in length, partly 15 inches and partly 12 inches in diameter, has also been laid from the filters to Whitletts Road for the supply of the high-level districts of Castlehill, Craigie, Hawkhill, and Whitletts.

The whole of the extension works have been carried out under 10 different contracts, from the Author's designs, at a total cost of about 37,000*l.*

The daily supply delivered to the burgh and water district is about 2¼ million gallons. Besides the supply to the burgh and outlying districts large quantities of water are supplied to institutions, railways, shipping, public works, estates, etc. The annual revenue is about 9200*l.*, and the present water rate within the burgh is 10*d.* per *l.* on rental.

The Corporation has water by-laws, approved by the sheriff in 1900, which provide—among the other usual conditions—that all fittings must be tested and stamped by the water department before being used.

SEWERAGE.

After an exhaustive examination of the condition of the old sewerage of the burgh, Mr. John Eaglesham, C.E., the Author's predecessor, submitted a detailed report to the Town Council in 1895, recommending the reconstruction of the entire sewerage system on modern principles. This new scheme was adopted by the Town Council, and has been designed and carried out by Messrs. J. and H. V. Eaglesham, C.E., Ayr. The work has been going on for the past nine years, and, at the present time, the final stage of this important work is approaching completion. The sewerage of the north side of the river, including that of a part of the adjacent burgh of Prestwick, flows in a system of fireclay pipes, varying from 9 inches to 2 feet in diameter. These are discharged into an intercepting sewer running along the river bed and a concentrating sewer at the lowest level, from which a main outfall sewer, 36 inches in diameter, of cast-iron pipes is carried out for a distance of 530 yards on the foreshore and discharged into the sea at the Euchar Rocks. The sewage on the south side of the river is similarly dealt with, the main outfall being 470 yards in length of 36-inch diameter cast-iron pipes fixed with screw piles to the bed of the foreshore and discharging at the St. Nicholas Rocks.

To fix the best points of discharge for the outfall sewers, experiments with floats were conducted under varying conditions of floods, tides, and winds, so that no disappointment would be experienced by the sewage being returned to the beach.

The new sewers throughout the burgh are mostly formed with 9-inch, 12-inch, 15-inch, 18-inch and 24-inch diameter glazed fireclay pipes jointed with Portland cement. The large sewers are of egg-shaped fireclay pipes, brick with fireclay sills, or brick barrel sewers built in cement, and where very deep strengthened with concrete. The intercepting sewers in the river bed and the outfall sewers are of 24-inch heavy cast-iron pipes, supported by cast-iron screw piles screwed into the substratum and secured by cast-iron rest and saddle pieces bolted to the piles.

Man-holes and lamp-holes (on the smaller sewers) are provided at all junctions, changes in line, and termination of sewers. The ventilation throughout is by open gratings at the street level. The sewers are grouped for the purpose of flushing from underground tanks, containing about 350 gallons of water. These are rapidly discharged by Adams' siphons. At the head of the smaller sewers Glenfield and Kennedy's tilting-boxes have been fixed for flushing purposes.

Storm overflows have been provided at numerous points in the system for relief during heavy rains and high tides.

The total cost of the entire scheme will be about 90,000*l.* sterling.

TRAMWAYS.

By the Ayr Burgh Act, 1899, the Corporation obtained Parliamentary Powers to construct and work tramways, both within and without the burgh. The Corporation tramways extend from Prestwick Cross on the north to Burns Monument on the south, a route length of 5 m. 3 fur. 5·04 chns., as follows: single line, 3 m. 2 fur. 7·33 chns.; double line (including passing places), 2 m. 0 fur. 7·71 chns., of which 3 m. are in the burgh and the remainder in the county. The first section of the tramways to be constructed was from Prestwick Cross in the burgh of Prestwick to St. Leonard's Church in the burgh of Ayr. This portion was opened in September 1901. The success of the undertaking was so marked from the commencement, that the Council resolved to proceed at once with the extension to Burns Monument, and this section was opened in May 1902.

The works embraced under the tramway scheme are the permanent way, underground cables and feeders, overhead equipment, seventeen cars, two car sheds, workshops, etc., at the Bellesley Hill depot, and eight houses for tramway employés adjoining. The Author had charge of the design and construction of the permanent way, tramway poles, cars, car sheds, and depot and workmen's houses, Mr. A. J. Fuller, late burgh electrical engineer, having charge of the electrical equipment, of power cables, and overhead work.

The greater portion of the permanent way was laid in macadamised roads, varying from 20 to 33 ft. wide in the carriage-way. The lines are generally straight with several

long winding curves. The gradients are very flat, the steepest being 1 in 22 for a distance of 100 yards approaching a railway bridge. The sharpest curve is at the town hall, where the inner rail is laid at a radius of 45 ft. The gauge is 4 ft. 8½ in., with 1⅛-in. grooves in the rails, and 1¼-in. grooves at the curves, and the distance between centres of double lines is 8 ft., and 10 ft. 1 in. where the poles are placed in the centre of the tracks. With a few exceptions, the Board of Trade limit of 9 ft. 6 in. between the rails and the kerbing has been complied with. There are nine passing places 3 chns. in length, three are 4 chns. in length, and one is 6 chns., making a total of thirteen passing places on the single line. These passing places are, with the exception of two cases, placed in sight of each other. In the two exceptions electric signalling apparatus has been fitted up, and the block system of working is used.

As was to be expected, the laying of a flat tramway line on the curved surface of country roads entailed considerable alterations to the sides of the roads; in fact, it may be said the roads were entirely re-made on both sides of the tramway line, and on account of the disturbance to them the footpaths were also reconstructed. The following are some particulars in regard to the construction of the permanent way. After excavating the roadway for a depth of 13 in., a concrete foundation 6 in. thick was laid, composed of four of 1½ in. whinstone, two of sand and small gravel, and one of Portland cement. This was put in to the exact gradient of the line, and well beaten down and smoothed on the top with fine concrete. The rails were laid on this foundation, and after they had been set to the proper gradient, the space between foundation and bottom flange of rail was carefully grouted and packed up with cement and sand, moistened and rammed in with beater picks until everything was perfectly solid. The steel rails and fish-plates used were manufactured by the Lorain Steel Co., Ohio, U.S.A., and were of the following chemical composition, viz.:—

Carbon		0·45 to 0·55 per cent.
Manganese		0·80 to 1·00 „
Silicon	(not to exceed)	0·10 „
Phosphorus	„	0·10 „
Sulphur	„	0·07 „

The rails are 6¼ in. deep, 5⅝ in. wide on bottom flange, 2⅞ in. over tread, groove and guard, weigh 90 lb. per lineal yard, and

to be put down in an honest way, consequently we have a true valuation.

Mr. CAMPBELL: You have an assessor?

Mr. YOUNG: Yes, we have a burgh assessor.

Mr. CAMPBELL: I wish we had.

Mr. YOUNG: Both for the burgh and the county as well. I quite agree with Mr. Campbell as to the high cost of street lighting in Ayr, but I may say the committee are looking very carefully into that, and are trying to reduce it by dispensing with unnecessary lamps. Of course, since our tramways were put down, we have had a good deal of public lighting to rearrange. We like to have the principal thoroughfares well lighted. We have tried incandescent gas lighting with very good results, both in illuminating power and low consumption. I was pleased to hear Mr. Campbell's good opinion of the tar macadam here. I understand that in England, almost every surveyor makes his own tar macadam, but in Ayr we do not require to do that. As to the consumption of water in Ayr, we average about 2¼ million gallons per day. The water area is about 4 times the area of the burgh, which is 2000 acres. We have the docks and railway companies; both large consumers, and most of the farms on the 25 miles of pipe line. Our supply is about 75 gallons per head per day, we sell about 16 gallons of that for other purposes, so that our consumption is up to about 60 gallons per head.

The President and Members of the Association attending the meeting were subsequently entertained to luncheon in the Town Hall. The Provost presided.

The afternoon was devoted to visits to the electricity works, the refuse destructor, the Auld Brig, the infectious diseases hospital, the tramway car sheds, and Burns's cottage and monument, where tea was partaken of. Unfortunately, a proposed visit to the waterworks had to be abandoned, owing to heavy rain.

stantial construction and ornamental in design. To give a five minutes' service in the town, ten minutes' service to Prestwick, and a fifteen minutes' service to Burns Monument, seventeen electric cars have been provided, each capable of seating fifty-seven passengers. These cars were built by Hurst, Nelson and Co., Motherwell, and are equipped with the firm's own type of truck, with 6 ft. wheel base, two 25 E.H.P. motors, and the British-Thomson-Houston Co.'s electrical appliances. Seven of the cars have the ordinary staircase, and ten have the "reversed" staircases. The average cost of the cars was 580*l*. each. An electric watering car has been provided for sprinkling the track, and for working the snow-plough.

The car depot at Bellesley Hill, Prestwick Road, contains one car shed 175 ft. long by 37 ft. broad, and another car shed and workshop 135 ft. long by 37 ft. broad, and also store rooms, engineer's office, muster room, smithy, oil stores, etc. There are six sidings in the sheds, providing housing accommodation for twenty-five cars, thus leaving room for additions being made to the present rolling stock. Continuous pits have been constructed in the floors for easy access to the undersides of the cars, and in one shed the sidings are entirely supported on beams and columns, the walls at the sides of the pits being omitted. It is found that this style of pit floor is the best for easy working and for the handling of parts from the undersides of the cars. There are two kilns for drying the sand used in the cars. The workshop is provided with the usual tools driven by an electric motor, and has an overhead travelling crane. The whole car sheds are heated by low-pressure hot water, and lighted by electricity. Eight dwelling houses have been erected adjoining the depot for housing certain of the tramway drivers and conductors, whom it is found advantageous to have at hand and under call for emergencies. A recreation hall has also been built in which many of the tramway employés spend their spare time and hold social meetings at frequent intervals.

The power for operating the tramways is obtained from the Corporation Electricity Works, Mill Street. The cables belong to the tramway department, and the price paid to the electricity department is as follows: First 200,000 units, 1½*d*. per unit; all above that amount, 1*d*. per unit. The number of units supplied to the tramways last year was 335,000.

The cost of the different sections of the work has been as follows:—

	£
Buildings, car sheds, dwellings, etc.	7,624
Permanent way construction	40,937
Underground feeders, cables, etc.	7,060
Overhead equipment	6,110
Rolling stock—17 cars, watering car..	10,308
Machinery and plant	725
	£72,764

From this the following rates per mile have been ascertained, viz.:—

	£
Permanent way construction, cost per mile of single track ..	5433·36
Underground feeders, cables, etc., cost per mile of route length	1298·40
Overhead construction, cost per mile of route length	1123·60

DISCUSSION.

The PRESIDENT: Mr. Young has given us a very interesting paper on the public works of Ayr. I am not quite clear as to the total cost of private street works per foot lineal. Is the price given in the paper inclusive of footpaths or is it for carriageways only?

Mr. YOUNG: Carriageways only.

The PRESIDENT: I should like to know the particular advantage of the Alphons Custodis chimney. When I was building a chimney—not quite so big as this—and invited tenders, these people quoted to their own specification, and not mine, and their price was considerably higher than the local tender to my own specification. I must say the chimney I built was not lined with fire-bricks throughout. Is there any particular object in brass-lining the waterworks pumps for pumping from the low level to the high level at Knockjarder? The question is whether there is any chemical action on iron, or whether it is simply to reduce friction. Did you have any trouble with the Board of Trade as to the tramway passing places? In Norwich the streets are so crooked that scarcely any two of the passing places are in sight of each other, but the traffic is worked without signalling and without much trouble. Of course the cars run to a time-table. What was the particular object in Ayr of having two systems of distribution for electricity—alternating as well as continuous current?

Mr. R. H. Dorman: I find you put tar macadam down in three layers, the total depth being 4 in. or 1⅓ in. for each layer. I should like to ask why you put it down in such thin layers. Is it because you cannot roll it in thicker layers with a heavy roller? I was at Battersea some time ago and found they had to use a 6-ton roller, as with a heavy roller the tar macadam rose up in front of it. I notice that Mr. Young says that a good coating of whinstone chippings from the stone-breaker is spread over the finished surface, as it is found that this prevents the loose stones from rising and in process of time the chippings work into the interstices of the metalling and make a very smooth surface. I find in most English counties that chippings are spread in this manner, and I am anxious to know if they are really beneficial. In steam rolling there is a great deal of stone such as limestone that never rises at all after being rolled; of course a great deal depends upon the time the stone is rolled. I think it is rather unnecessary expense putting these chippings on and rather a nuisance. With regard to the Auld Brig of Ayr, it is quite evident that three of the arches are distorted, and from Mr. Young's paper it appears that the foundations are failing. I have been informed that at a depth of 3 ft. 6 in. below the present foundation there is a good foundation to be obtained. I should imagine that if you put down cofferdams, cut out the present foundations, and put in blocks of concrete, you would not have much difficulty in making the Auld Brig all right. I have only looked at the bridge, but what I have suggested seems quite possible. As regards the chemical composition of the tramway rails, I would like to ask if that is the only test applied, and why you insisted upon that particular test in the specification, because it seems to me rather test for the manufacturer, and that the engineer should depend rincipally upon a mechanical test.

Mr. A. H. Campbell: For a population of just under 30,000)7,000*l*. is certainly a very remarkable rateable value. We ho live in the south, are content if we can get a rateable value between 4*l*. and 5*l*. per head. I know that in Edinburgh and ith and probably also in Ayr, there is a burgh assessor who lues the whole of the properties of the town. In England we ve the much more cumbrous and less efficient system of valua- n by overseers. With regard to private streets, if Mr. Young cludes the cost of paving footways which is insisted upon as an

essential equipment of a street before it is taken over by a local authority the cost works out at about 10*s.* per lineal foot of frontage. I do not think that is excessive. And on this matter, I speak from my experience in London, where, if we come out at 10*s.* per lineal foot, we congratulate ourselves upon our moderation. I would also like to compliment the administrators of Ayr upon the low cost of the maintenance of the highways, but I regard their street lighting as luxurious. Anyone who goes through the streets at night and sees those miles of arc lamps must realise that it is a costly matter. The 120 electric arc lamps at 23*l.* each, mean 2760*l.* for electric street lighting for a town of under 30,000 people. As a matter of municipal trading enterprise, naturally the more you pay for the lighting of your town, the greater the revenue for the electricity department, but it is at the expense of the ratepayers' pockets. We have to consider not one department, but the ultimate economy of the whole town. Therefore I am glad to see the introduction of incandescent gas lighting, because in that direction lies the greatest efficiency and without doubt the greatest economy in street lighting.

Mr. J. R. WILSON: I should like some information as to the consumption of water in Ayr. I understand some years ago it was 100 gallons per head per day, which seems very excessive.

A hearty vote of thanks having been unanimously accorded,

Mr. J. YOUNG, in reply, said: As to carriageways, the cost of 7*s.* and 6*s.* 3*d.* include the kerb; two channels, making up the roadways and macadamising, but not the footpaths. If I add the cost of a concrete footpath on one side it brings the cost up to 9*s.* 5*d.* and 8*s.* 8*d.* per lineal foot of frontage respectively, or an addition of 2*s.* 5*d.* per lineal foot. The advantage of the Alphons Custodis chimney lies solely in the manner and material with which it is constructed. The use of cellular bricks prevents cracking, and you also get a lighter stack. Further, the cost is much less than building a chimney with an independent lining from top to bottom. I designed a 120 ft. chimney of that kind for the destructor, with certain heights of 14 in., 9 in., and 4½ in. brickwork for the internal chimney lining. I went into the relative costs and found the Alphons Custodis chimney was very much the cheaper. I got a smaller chimney and a better lining by having the corbelling and lining in 16 ft. stages. Instead of having to take down a large portion

of the lining, you can take down a part of one of the 16 ft. stages and renew it. Taking it bulk for bulk there was a difference of 160*l.* in favour of the Alphons Custodis chimney. It was for that reason that I recommended my committee to give it a trial, and I am thoroughly satisfied it is built on right principles. Another point is that with the ordinary construction you require the stability of the chimney to be calculated without the lining, while here you have the advantage of the lining of the chimney being added in the calculation of the stability. As to the brass-lining of the pumps, that was simply because I was using a brass piston, and had brass piston rings. It is the custom in Scotland to brass line all pumps. We have had no trouble whatever with the signalling apparatus on the tramways. As regards alternating *versus* continuous current, being a small installation, no doubt it was desired to lay it down at as little cost as possible. That may be the cause for introducing the alternative current at the beginning. Owing to the demand for current for tramways and motors, the Corporation thought it necessary to face the question of putting in continuous current, and a great many of the consumers have been changed over to the continuous current. The public lighting is practically all run by the alternating current, and the continuous current is used for house supply. As to the tar macadam, the material principally used is slag from blast furnaces and limestone. We cut a macadamised road down, leaving the old core in as a foundation, and then they lay the tar macadam in three different layers, finishing it at 4 in. thick. The contractors ask me to roll the first coat with the steam roller, and use their own 5- or 6-ton roller for the two upper coats.

As regards the chemical composition of the tramway rails the proportion of carbon has a good deal to do with the wearing property of the rail. I think it is only proper when specifying rails that there should be some allowance for variation in the composition—that is why we put the carbon so low as 0·45 to 0·55. When the rails came, they were of such good quality, so true, so straight, and so thoroughly well made, that I had no hesitation in dispensing with any mechanical tests. The valuation of the burgh is about 6*l.* per head, but it never struck me that the valuation of the English boroughs was so low. All I can say is that the valuation of towns in Scotland has

Clause 34 is, the Author believes, a new clause for a Water Bill. It was drawn to give the Council the same control and power of inspection for water services that the Public Health Act, 1875, gives for drains; the point being that there is nothing in the Waterworks Clauses Acts which empowers an authority to insist that water services shall be inspected before being covered up. This Council had previously submitted a by-law to this effect when putting their Water By-laws before the Local Government Board for their sanction, but it had been struck out as *ultra vires*. The clause reads:—

> "The provisions of Section 37 of the Act of 1898, with respect to by-laws, shall extend to enable the Council to make by-laws for the inspection by the Council of any service pipe or any apparatus connected therewith intended to be covered over before the same is covered over, and the Council may by such by-law require notice in writing to be given to them as soon as such pipe or apparatus is ready to be covered over, so that the same may be inspected and approved."

The award of the umpire in the arbitration for the price to be paid by the Council for the purchase of the works was 127,880*l.*; and when to this were added the company's mortgage debt, expenses of the Act, arbitration and winding-up of the company, compensation to company's officers, and legal expenses, the total cost to the Council became 148,111*l.* for works on which the total capital outlay by the company only amounted to 72,025*l.* This heavy expenditure, much in excess of the highest estimates that had been formed, together with a further expenditure of 40,000*l.* to which the Council were committed for electricity works in order to avoid the loss of their provisional order, and the formation of a monopolist company, made the Council anxious to delay these new works of water supply as long as possible. But the exceptionally dry year of 1902 made it evident that more water must be provided, and in November of that year they decided to undertake the construction of the Thorpe Malsor reservoir, that being the nearer of the two reservoirs to their existing works at Cransley, and appointed the Author their engineer to design and carry out the works.

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MIDLAND DISTRICT MEETING AT KETTERING.

September 2, 1905.

Held in the Carnegie Free Library, Kettering.

W. HARPUR, M. INST. C.E., PAST-PRESIDENT, *in the Chair.*

THE Chairman of the Council (F. Mobbs, Esq., J.P.) received the Members, and offered them a hearty welcome to Kettering.

Mr. Harpur, on behalf of the Association, thanked the Chairman of the Council for the kind welcome that had been offered them.

Mr. H. Richardson was unanimously re-elected Hon. Secretary for the Midland Counties District.

KETTERING WATERWORKS, NEW STORAGE RESERVOIR, ETC.

BY THOS. READER SMITH.

WHEN, in 1898, the Kettering Urban Council promoted a Bill in Parliament to obtain power to compulsorily purchase the waterworks undertaking from the company then owning them, it became very evident that it would be necessary before long to obtain an additional source of supply; estimates showing that at the then rate of increase in the water consumption the available surplus water would all be taken up in four years.

The works purchased comprised a storage reservoir of

160,000,000 gallons capacity, near the village of Cransley, with a gathering ground of 1805 acres. The average rainfall on this area, as determined by the late Professor Symons for the arbitration, amounted to 26½ inches, and the average of three consecutive dry years 21·2 inches, leaving, after deducting 16 inches for evaporation, 5·2 inches available for collection, equal to a daily supply from this source of 581,932 gallons. From this 35,137 gallons per day had to be deducted for compensation water, leaving 546,795 gallons per day available for supply to Kettering. There were also two well pumping stations, together equal to 110,000 gallons daily, making a total available supply of 656,795 gallons per day.

The population of Kettering was then about 28,000, and the number of water consumers, estimated at 5·3 per house taking water, was 17,315; the daily consumption was 485,820 gallons, leaving a surplus of 170,975 gallons, which with an annual increase in the daily consumption of 40,000 gallons would evidently not last more than four years.

The Council thus had early to consider the question of additional works, and in 1899 they engaged the late Mr. James Mansergh, M.Inst.C.E., to advise them as to what works should be undertaken, and to assist them in obtaining the necessary Parliamentary powers.

Mr. Mansergh's then partner, Mr. Geo. R. Strachan, M.Inst.C.E., soon after made a careful examination of the country in the neighbourhood of the Cransley reservoir, and from there as far as Naseby, where the river Ise rises, with the hope of finding a source which would allow of a gravitation scheme and meet all the requirements of Kettering for the next twenty or thirty years. No such position for a reservoir could, however, be found, the configuration of the country only affording very small collecting areas for reservoirs at a sufficient elevation for a gravitation scheme. Mr. Mansergh, therefore, recommended in his report that reservoirs should be constructed in two valleys immediately adjoining our present gathering ground at Cransley, the sites selected being at such levels that the water would gravitate to the Cransley works where the filtration and pumping would be done, the existing plant being enlarged from time to time as the water consumption increased.

These two collecting areas are almost equal, the Thorpe Malsor area being 1330 acres, and the Orton area 1360 acres.

The estimated quantity of water available from the former was 399,000 gallons per day, and from the latter 397,500, the smaller quantity being estimated from the Orton valley, which is the larger area, on account of its being in reality two valleys, the southern valley, in which the reservoir would be situated, having an area of 660 acres, and the northern of 700 acres, 95 per cent. only of the water available from this portion being included in the estimate, as it would be brought round to the reservoir by a pipe and small catch-water dam, so that at times there might be some loss of water. The average dry weather rainfall for these calculations was taken at 20·8 inches, which, after deducting 16 inches for evaporation, leaves 4·8 inches available for collection. This is a smaller basis than for the previous calculation, as it was considered that recent dry years had lowered the average.

The compensation water to be given to the streams was put at 115,340 gallons per day from the Thorpe reservoir, and 116,025 gallons per day from the Orton reservoir, these quantities being about midway between one-fourth and one-third of the total quantity available, and leaving for consumption in Kettering 283,660 gallons per day from Thorpe, and 281,475 gallons per day from Orton, or a total of 565,135 gallons per day from the proposed new works.

The total available water supply for Kettering according to these calculations would thus become:—

Works	Total Collectable per day.	Compensation per day.	Total available per day.
	gallons	gallons	gallons
Cransley, reduced to 4·8 inch rainfall	537,168	35,137	502,031
Thorpe Malsor	399,000	115,340	283,660
Orton	397,500	116,025	281,475
Wells at Clover Hill and Weekley ..	—	—	110,000
		Total	1,177,166

In 1900 the Council went again to Parliament to obtain the necessary powers to construct the works advised by Mr. Mansergh. These comprised the two reservoirs referred to: the Orton reservoir to have an embankment 27 feet high, a

capacity of 90,000,000 gallons, and a top water level of 360 feet above O.D., with a main delivering the water at the Thorpe reservoir; the Thorpe reservoir to have an embankment 46 feet high, a capacity of 140,000,000 gallons, and a top water level of 335 feet above O.D., the delivery main from this to convey the water from both reservoirs to the Cransley reservoir. The Cransley reservoir has an embankment 32 feet high, a capacity of 160,000,000 gallons, and a top water level of 298·5 feet above O.D. At these works there were three filter beds, each of 500 square yards area, and a pair of Worthington pumping engines each of a capacity of 500 gallons per minute, or 720,000 gallons per day for 24 hours continuous pumping, delivering water to the town through a 12-inch main, 4400 yards in length, the working head against the pumps being about 70 feet. Mr. Mansergh's scheme further provided for two additional filters, a filtered water tank of 100,000 gallons capacity, and additional pumps at Cransley; a high pressure tower with tank of 100,000 gallons capacity in the town at Clover Hill to improve the pressure at the higher parts, with pump for supplying the same from the present service reservoirs, and new trunk mains arranged to serve the town in three separate districts, one high level and two low level. The estimate for the whole was 126,500*l.*

The Bill, which cost the Council 3291*l.*, received the Royal Assent in July 1901. It contained several provisions which may be of interest:—

Clause 17 dealt with compensation water and required one-third of the total available supply to be given to the streams. Mr. H. Sowerby Wallis was appointed "referee" to determine this amount, and after a special series of rainfall measurements extending over three years, from midsummer 1901 to midsummer 1904, he reported that the available rainfall for the Thorpe Malsor collecting area was 5·36 inches, and for the Orton area 5·44 inches, and that the amount of compensation water due from each would be 147,350 gallons per day, and 149,000 gallons per day respectively. This gives a mean available rainfall of 5·4 inches, or 0·2 inch larger than the amount determined by Professor Symons in 1898 for the Cransley area adjoining, so that it would appear that so far as compensation water is concerned we have suffered somewhat in consequence of the wet season of 1903.

Taking Professor Symons's estimate for the Cransley area, and these returns for Thorpe Malsor and Orton, the total water supply at present available for Kettering is as follows :—

Works.	Total Collectable per day.	Compensation per day.	Total Available per day.
	gallons	gallons	gallons
Cransley	581,932	35,137	546,795
Thorpe Malsor	442,050	147,350	294,700
Orton	449,520	149,000	300,520
Clover Hill and Weekley Wells ..	—	—	110,000
		TOTAL	1,252,015

Clause 30 empowers the Council to make by-laws for the sanitary protection of the areas from which they collect their water. It is as follows :—

"(1) The Council may make by-laws for securing the purity of the water which they are authorised to impound or take for the purposes of any of their waterworks, and may by such by-laws prescribe the construction, maintenance, and use of proper sanitary conveniences and make provision for the prevention of nuisances and the prevention or regulation of any act or thing tending to pollution of the water.

"(2) The by-laws made under this section shall be in force within the drainage areas or within so much of those areas as may be defined in the by-laws.

"(3) All by-laws made under this section shall be subject to the approval of the District Council of every district comprising any part of the area within which it is proposed that they shall be in force, provided that such consent shall not be necessary where, in the opinion of the Local Government Board, it has been unreasonably withheld.

"(4) The Council shall pay compensation to the owners of, and other persons interested in any lands in respect of which by-laws shall be made under the provisions of this section who shall be injuriously affected by the restrictions imposed by such by-laws, and such compensation shall be settled by two Justices in accordance with the provisions of the Lands Clauses Acts as in the case of claims for compensation under Section 22 of the Lands Clauses Consolidation Act, 1845."

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These works comprise an embankment, with culvert under, valve tower, overflow weir and waste water channel, and a

culvert bridge at the upper end of the reservoir with raising the road crossing the stream there to keep it well above the top water level of the reservoir which will back up to this point. Arrangements had also to be made to supply the village of Thorpe Malsor with filtered water as compensation for the loss of their existing supply of spring water by a ram working in the valley on the site for the new reservoir, and which would be drowned when impounding the water by the new works; also for the diversion of the drainage of the village of Loddington, situated a mile above the new reservoir embankment; and a caretaker's cottage is to be built at the entrance to the site.

SITE.

The site of the works is three miles out of Kettering in the valley adjoining the south side of the main road to Market Harborough and Leicester, and a little west of the cross road to the village of Thorpe Malsor. The strata of the neighbourhood, and generally round Kettering and over a large portion of Northamptonshire and parts of adjoining counties, consist of a series of beds of sands, sandstones, limestones, and ironstone, known as the Northampton sands; they form part of the inferior oolite, and rest on the blue clay of the upper lias. The latter is locally a very thick bed of clay much worked for brickmaking, and has been worked on the reservoir site for clay for the puddle wall of the embankment. The Northampton sands form the hills and ridges of the district; they are very porous, and many springs run from them along the line of junction with the clay beneath. The valley itself is very suitable for a reservoir site, being deep with steep sides, the cross section resembling the letter V.

EMBANKMENT.

The embankment will be 840 feet long at the top and 46 feet high at the centre; the width at the top will be 12 feet, the inner slope 1 in 3, and the outer slope 1 in $2\frac{1}{4}$ for the upper half and 1 in $2\frac{3}{4}$ for the lower half, with a level benching or berm, 4 feet wide, at the junction of the two slopes.

The site of the embankment was prepared by stripping the surface to a depth of 12 inches to clear it of all sod and soft soil; trees on the site were felled and the roots thoroughly

pieces to receive the puddle wall and form a tight joint, the puddle being worked round the wings on the water side to prevent creep.

The clear width of the overflow weir is 30 feet, being 1 foot of overflow to 44 acres of gathering ground. The overflow at the Cransley reservoir has a clear width of 36 feet, which works out to 1 foot of overflow to 50 acres. The proportionately wider width has been given at the new works as the gathering ground has for a considerable area a more rapidly inclined surface than the Cransley gathering ground, so that heavy rainfalls will reach the reservoir sooner. A steel footbridge is placed over the overflow of similar construction to the valve tower bridge.

Waste-water Channel.

The waste-water channel from the overflow to the old brook course is reduced from 30 feet in width at the weir to 10 feet at the end of the curve leading from the weir until it is joined by the channel from the culvert under the bank, from which point it is 12 feet wide to the boundary. Beyond this a new cut has been formed, on a give and take line as regards adjoining owners, to give a better delivery into the brook and prevent any flooding in time of storm.

The floor of the channel, where on the hill side, is formed in steps with a gradient in the direction of flow of 1 in 120. The whole is of concrete. The kerbs at the steps are of granite ballast and cement in the proportion of 4 to 1, and were formed in position. The concrete flooring was put in in bays about 6 feet wide; the bottom 6 inches is of broken brick ballast and cement in proportion of 6 to 1, and the upper 3 inches of granite ballast and cement in proportion of 4 to 1, and placed on the bottom portion immediately after the latter had been put in position, so as to form a perfectly solid block; the surface was worked up true with the trowel, but not rendered. The flooring is flat in cross section, except for the lower flat length below the junction with the channel from the culvert, which is dished 6 inches deep to better convey compensation water.

The side walls are of rubble stone walling in cement mortar, 18 inches thick at the top, the back being vertical and the face battered 1 in 8; buttresses about 10 feet apart centres are

first a good deal was obtained from the excavation for the puddle trench, but the bulk has come from an excavation specially made for this purpose in the blue clay in the bed of the reservoir site. After being dug it is well watered and allowed to weather for a few days and then passed through a pug mill so that it is thoroughly tempered before being taken on to the bank and has then only to be placed in position and trodden in. This is done in layers, 6 inches thick, spread uniformly over the width of the puddle wall, several layers stepped back one behind the other being usually brought on together. Special care was taken to secure a good joint with the blue clay at the bottom of the trench by working the surface of the sides and bottom and the clay puddle well into one another. The surface of the puddle wall, except where fresh material is being worked in is kept covered with sacking and well watered.

The materials for the embankment have also been obtained on the site of the works. Much the greater part has been specially excavated from the upper portion of the sides of the valley, particularly at the north end of the embankment, where the surface has been stripped to a depth of as much as 12 feet, the overflow being constructed here on the solid side of the valley, and an area of 13,000 square yards being lowered below top water level forming an extension of the reservoir in this direction. The materials consist of limestone and ironstone measures with subsoils of similar character. They have been placed in the bank in layers of about 9 to 12 inches in thickness, level longitudinally but inclined transversely towards the puddle wall at an inclination of 1 in 12 and well consolidated by rolling and by the trampling of horses working the tramlines for bringing on the material. No more clay has been put in the embankment than had necessarily to be dealt with from the various excavations, and this, where used, has been spread in layers as above and well sandwiched in between the other materials, except that used for selected material next the puddle wall, where the softer clay fresh from the excavations has been rammed solidly in. The thickness of the selected material is 6 feet on each side of the puddle wall at the top and thickens out below with outer slopes of 1 horizontal to 3 ver.ical. Generally in forming the embankment the finer material has been placed next the selected material, and a considerable quantity of stone has been placed in the outer parts.

The outer slope of the embankment is to be covered with 6 inches of soil and sown with grass and clover seed, 30 lb. to the acre. The inner slope is to be pitched with local stone, a large quantity being obtained in the excavations for material for the embankment. For the lower portion, from the foot to the middle draw-off, that is to within a vertical depth of 24 feet below top water level, the pitching is 6 inches deep on a bed of rubble 6 inches thick; between the vertical depths of 24 feet and 12 feet below overflow the pitching is to be 9 inches deep on 6 inches of rubble, and above this level to the top of the embankment the pitching is 12 inches deep on 9 inches of rubble. The pitching is to be done in roughly level courses, well rammed and finished to an even surface, and the interstices well grouted with small stone.

Culvert.

The culvert for the draw-off pipes is placed in a trench under the embankment, cut in the ground part way up the north side of the valley so that it is completely enclosed in the solid ground and protected from stresses arising from settlement of the bank. It is of horseshoe section 6 feet diameter, constructed of two rings of brickwork in cement mortar, one part cement to two parts sand, with a rendering of cement mortar ½ inch thick between the two rings; the inner ring is of Hamblet's blue wire-cuts made with radial sides to suit the curves. The brickwork is placed on a foundation bed of cement concrete and surrounded with cement concrete of the form and dimensions shown on the drawings, the foundation bed being 12 inches thick under the lowest point of the invert and rendered over ½ inch thick to receive the brickwork, the thickness at the sides and over the crown being 15 inches at the inner and outer ends, and 21 inches for the middle length, except that a greater thickness and special formation is used at the centre where the puddle wall crosses, and projecting rings are formed to ensure a tight joint with the puddle and to prevent any creeping of water along the sides. It was necessary here to sink 8 feet below the level of the foundation bed of the culvert to get well down into the blue clay to ensure a watertight construction in the line of the puddle wall. This was taken a little below the bottom of the puddle trench, and a solid pillar of concrete brought up to carry the culvert over, and the

rings to form the joint with the puddle wall were carried up from the bottom of this pillar. The sides of the pillar and of the rings were formed with a batter so that the puddle in settling would tighten up in its seat and make a perfect joint, and the crown of the concrete over the culvert is here finished as a pointed arch to strengthen the work and assist settlement.

Two other creeping rings of concrete are formed on the inner length of the culvert, one a short distance from the tower, and one about midway from the centre at the change of thickness in the concrete; and the whole of the inner length is covered with clay puddle 2 feet 6 inches thick, which is well shaped up into the puddle wall at the centre.

The concrete for the culvert is composed of 4 parts ballast to 1 part cement, the ballast for the outer portion being broken brick, $1\frac{1}{2}$ inch gauge, with smaller material and sand, the proportions being 2 parts broken brick, 1 part sand; for the centre and inner part of the work broken granite was used for ballast, the proportions being one-third each of 1 inch granite, $\frac{1}{2}$ inch granite, and sand.

The centre of the culvert has been formed entirely of concrete for a length of 7 feet 4 inches, the cross section being circular and the longitudinal conical, so that it may be securely closed with a plug of concrete if thought desirable.

Valve Tower.

The inner end of the culvert terminates at a valve tower situated just inside the toe of the inner slope of the embankment. The position was determined by the draw-off valves for the main to Cransley, which are placed at 12 feet, 24 feet, and 36 feet below top water level, the arrangement being that the bottom draw-off, together with the compensation draw-off which is 3 feet lower, is placed in the fore-bay channel at the foot of the tower, and the next draw-off in the side 12 feet higher, is just above the pitching on the slope of the embankment. In this position the tower has been brought in as far as possible without having to take a draw-off through the embankment, and at the same time is practically free from any pressure from the embankment which might be very heavy during settlement.

The tower stands on a bed of concrete 3 feet thick; it is built square at the base and octagonal when clear of the

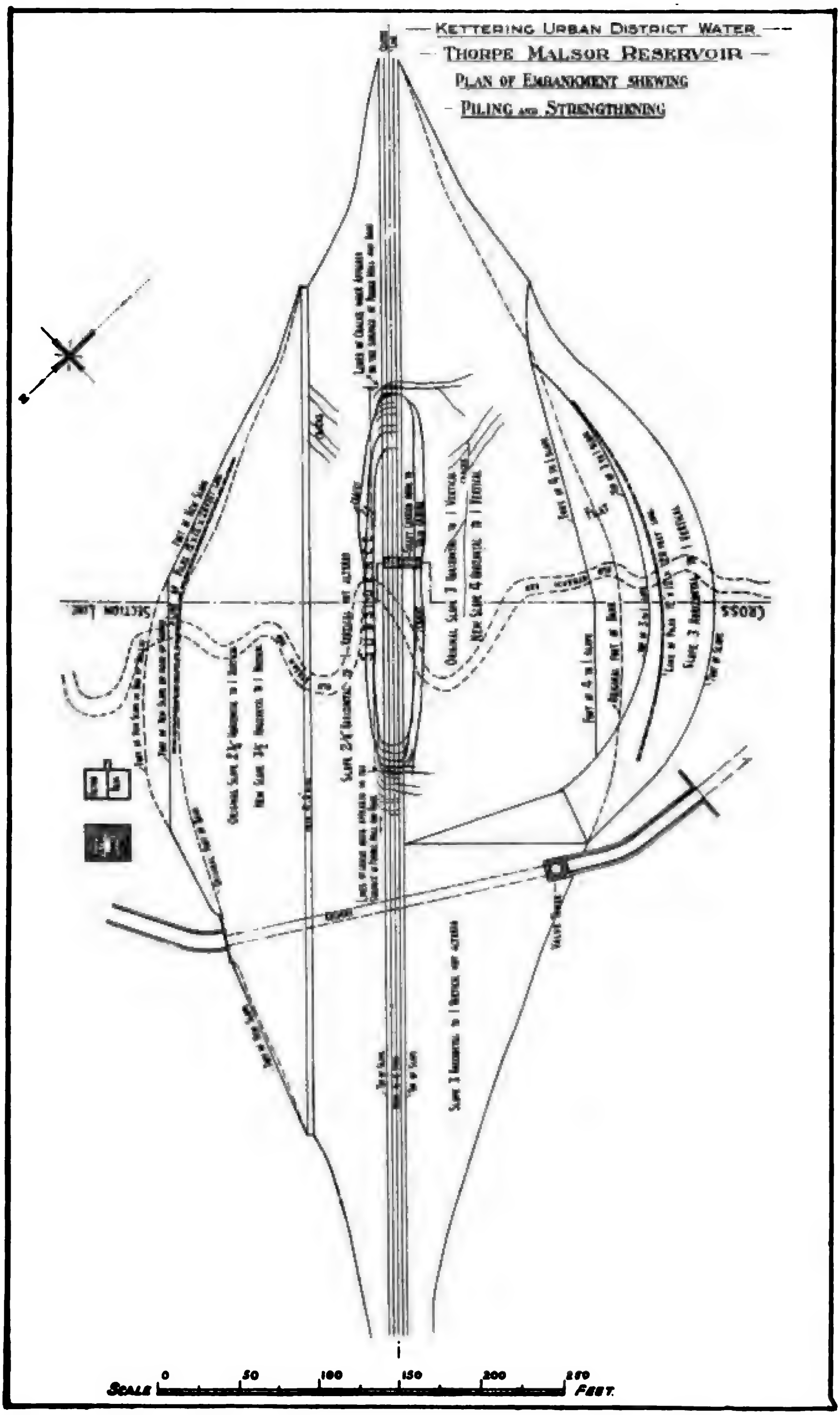
embankment, and oversailed with corbels at the top to enlarge the platform to receive the standards for the outer sluices. The square base is entirely of concrete, 1 part cement to 4 parts granite ballast as described above, and is provided with a wing wall on each side to form a stop and key for the puddle which is well rammed down the sides and joined on to the puddle over the culvert. Above the square base the tower has an outer facing of blue brindle bricks in cement mortar of equal parts of cement and sand, backed with cement concrete mixed 1 part cement to 3 parts granite ballast, the back of the brickwork being rendered with cement mortar. The outer brick facing is 9 inches thick, every fourth course being 13½ inches to form a key for the concrete. The concrete was filled in between the brickwork and a centre core in 6-inch layers well rammed together. The draw-off pipes where passing through the walls are provided with creeping flanges with 3 inches of cement mortar well worked round them.

The walls of the tower are 3 feet thick in the square base, except the front wall which is 3 feet 6 inches, the thickness being reduced to 2 feet 6 inches for the upper portion above the level of the upper floor. The walls are coped with flat Derbyshire slabs, 12 inches thick, well clamped together, the centre opening being filled in with a cement concrete floor, so that the whole upper surface forms a platform from which the valves and outer sluices are worked.

Each draw-off is provided with a 12-inch valve inside the tower and a 12-inch sluice with grating over the opening on the outside. The valves are worked from standards on the top platform with hand wheels and worm gearing, and the outer sluices from standards on the outer edge of the platform with nuts worked by hand wheels. The regulation of the water drawn off will be by the valves, the sluices only being used to facilitate any repairs to the valves, etc., inside the tower. Floors of cast-iron grates are placed in the tower at the levels of the upper and middle draw-offs, and access is by an iron ladder from a manhole cover in the top platform; a ventilator is also provided in the centre of this platform.

From the foot of the tower two draw-off pipes, each 12 inches diameter, one for compensation water and one for conveying the water to the Cransley works, are taken through the culvert on small pillars with stone pads hollowed to receive the pipes.

PLATE NO. 3.



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pieces to receive the puddle wall and form a tight joint, the puddle being worked round the wings on the water side to prevent creep.

The clear width of the overflow weir is 30 feet, being 1 foot of overflow to 44 acres of gathering ground. The overflow at the Cransley reservoir has a clear width of 36 feet, which works out to 1 foot of overflow to 50 acres. The proportionately wider width has been given at the new works as the gathering ground has for a considerable area a more rapidly inclined surface than the Cransley gathering ground, so that heavy rainfalls will reach the reservoir sooner. A steel footbridge is placed over the overflow of similar construction to the valve tower bridge.

Waste-water Channel.

The waste-water channel from the overflow to the old brook course is reduced from 30 feet in width at the weir to 10 feet at the end of the curve leading from the weir until it is joined by the channel from the culvert under the bank, from which point it is 12 feet wide to the boundary. Beyond this a new cut has been formed, on a give and take line as regards adjoining owners, to give a better delivery into the brook and prevent any flooding in time of storm.

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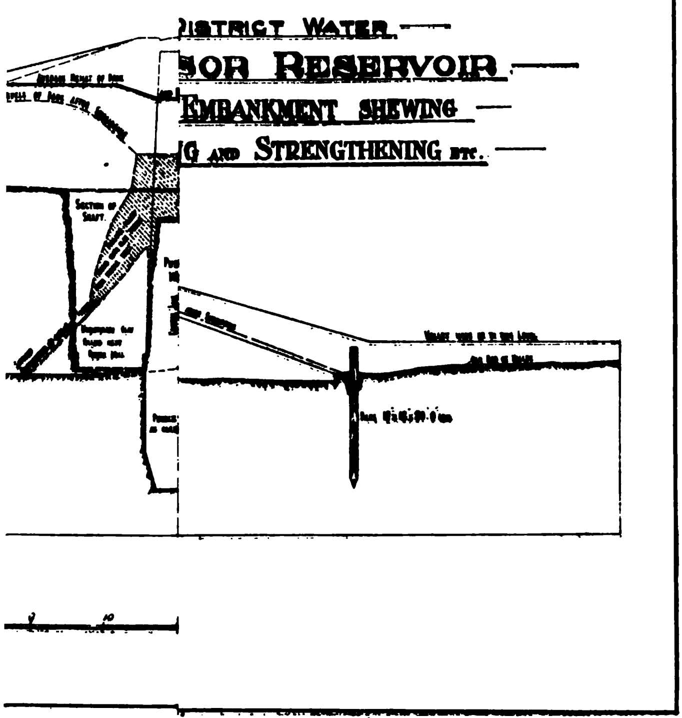
The side walls are of rubble stone walling in cement mortar, 18 inches thick at the top, the back being vertical and the face battered 1 in 8; buttresses about 10 feet apart centres are

PLATE NO. 4.



RETT & SONS, 19 BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

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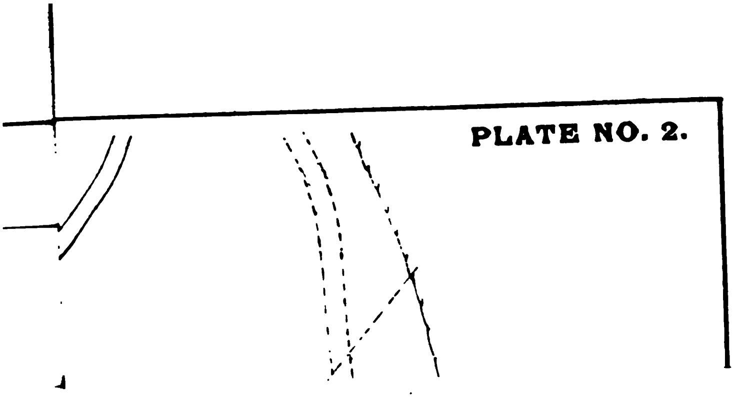

PLATE NO. 2.

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N DISTRICT WATER

PLATE NO. 7.

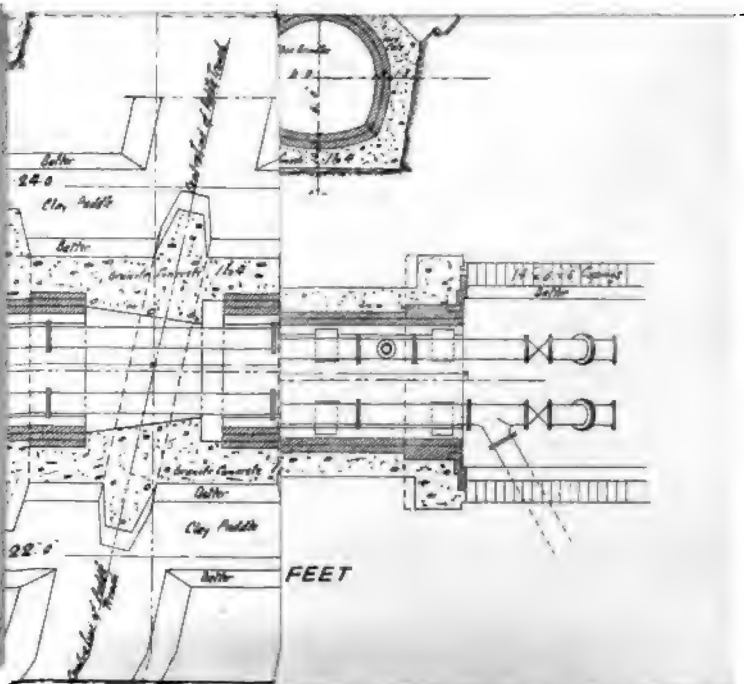

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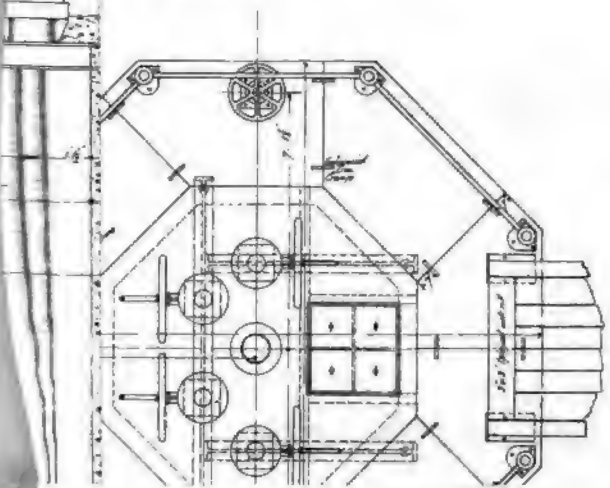
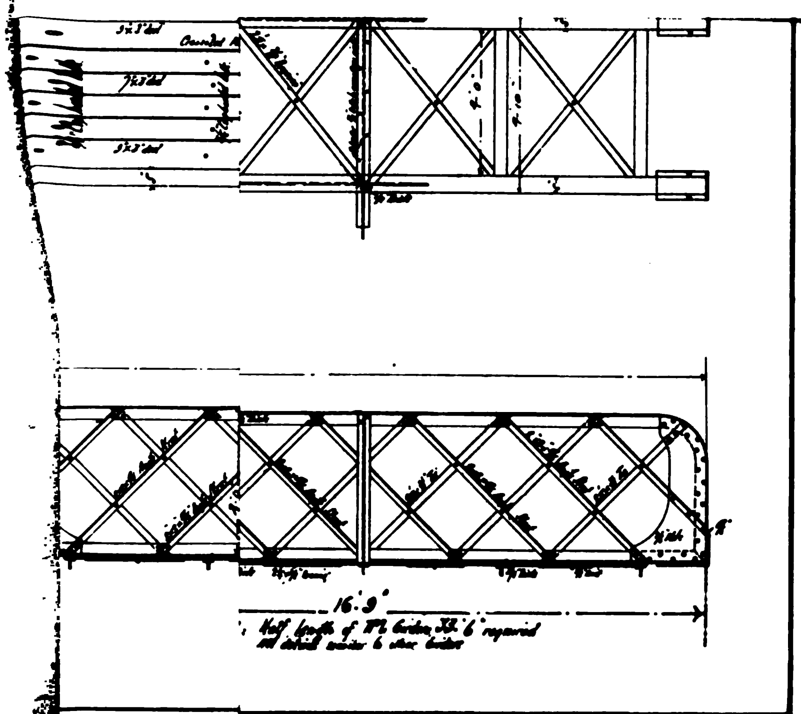
PLATE NO. 7.

N DISTRICT WATER

SOR RESERVOIR

TOWER.





[PH]OTO-LITHO. R.J EVERETT & SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

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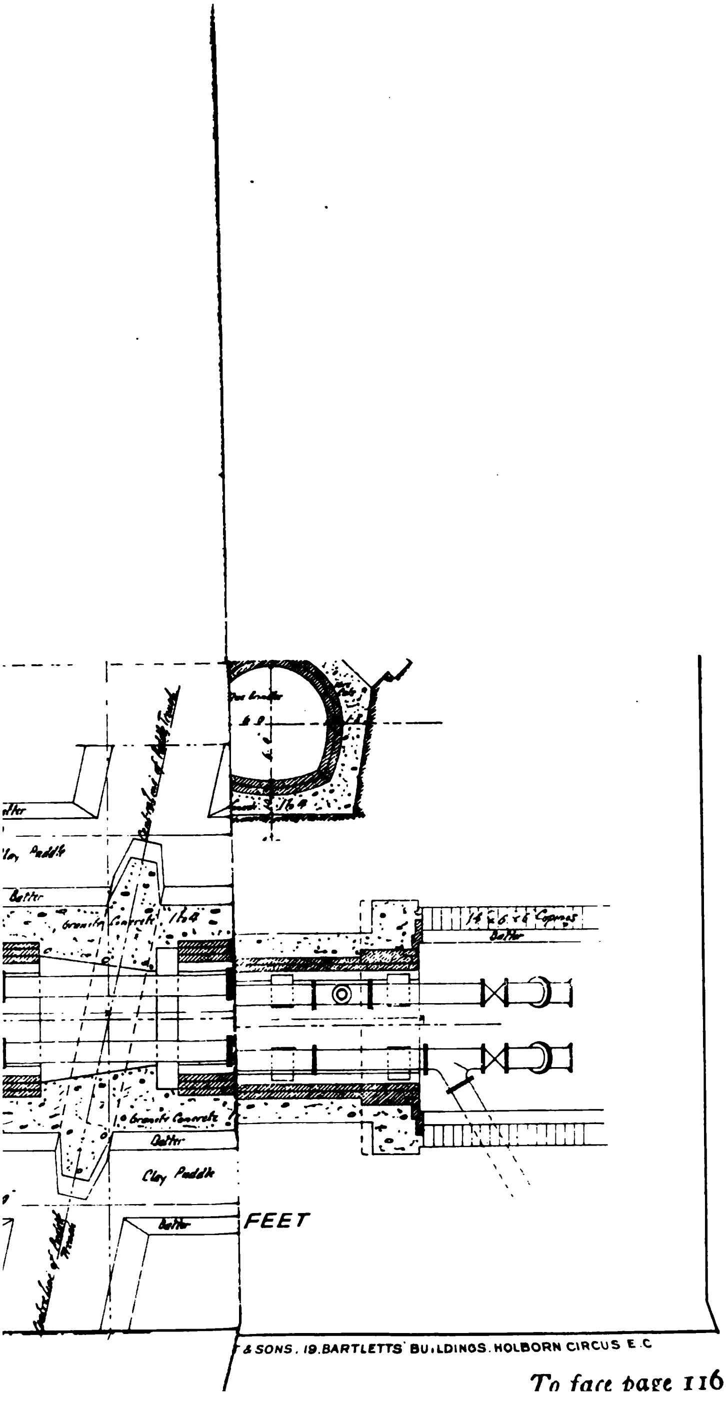
PLATE NO. 7.



& SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS E.C

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PLATE NO. 7.

N DISTRICT WATER

SOR RESERVOIR

TOWER.

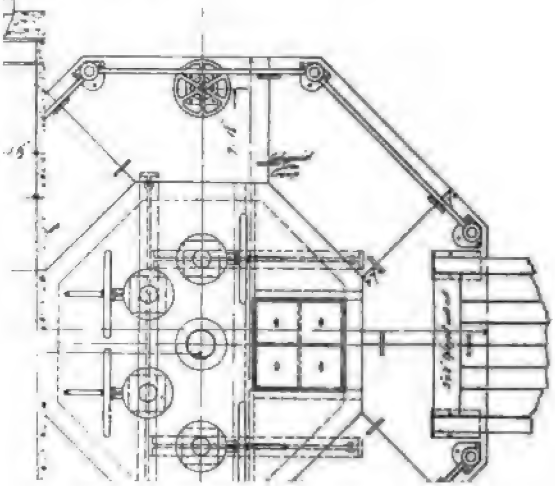
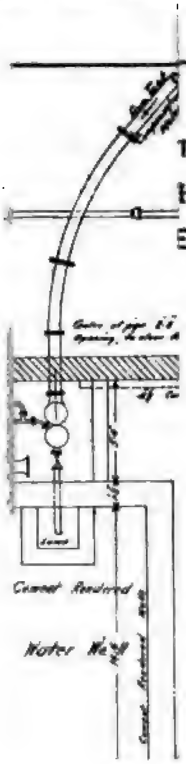


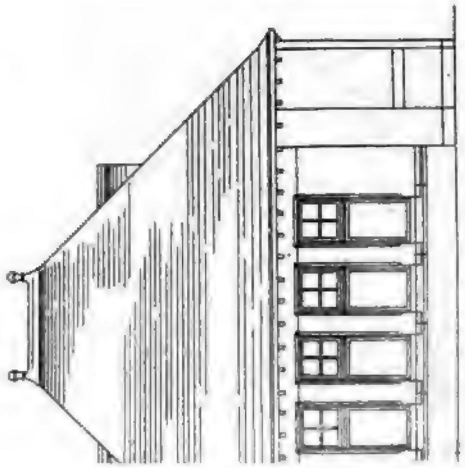
PLATE NO. 11.

…TTERING URBAN DISTRICT WATER

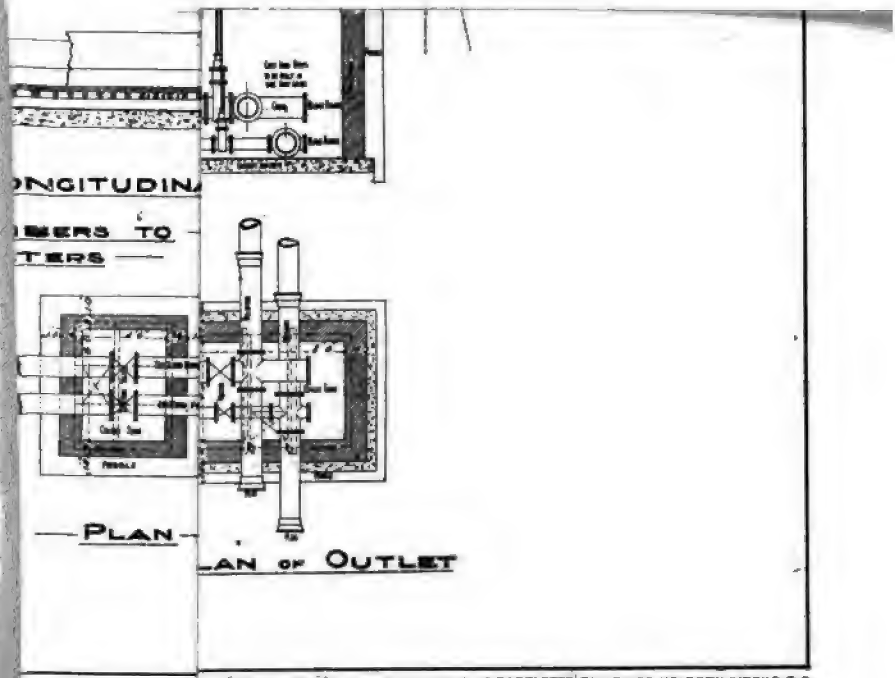
…HORPE MALSOR RESERVOIR

…E HOUSE, FILTERS AND GAUGING BASIN.





NORTH ELEV^N



"PHOTO-LITHO" R.J. EVERETT & SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

To face page 116.

added when the walls are surcharged. The coping is of best pressed Staffordshire double bull-nosed coping bricks, 14 inches wide, set and jointed in cement mortar.

A small cart bridge is built over the lower part of the waste water channel with a brick segmental skew arch in three half-brick rings in cement mortar, the soffit and ends of the arch and bases of parapet walls being faced with blue brindles.

Supply to Thorpe Malsor. Meter and Gauge House.

The impounding of water on the site of this reservoir will drown out a hydraulic ram now pumping spring water up to the village of Thorpe Malsor. This was provided, and the springs collected by the owner of the estate; the Council's Bill therefore contains a clause making it obligatory on the Council to give a free supply of filtered water from the reservoir to Thorpe Malsor, the quantity being put at 4000 gallons per day in a continuous stream.

This demand is being met by the construction of two small sand filters near the foot of the embankment, the filtered water from which will be forced up to Thorpe by a hydraulic ram worked by the compensation water to be given from the reservoir. To work the ram the compensation water will be delivered into a small tank over the end of the culvert under the embankment, and a 6-inch main of flanged pipes with faced joints carefully laid with an easy curve, will deliver the water to the ram. After each stroke of the ram the water working it will escape at the foot-valve and flow to the gauging basin adjoining the meter and gauge house. An overflow from the tank over the end of the culvert will also bring any surplus water to the same gauging basin, and the flow over the gauging weir will be automatically recorded by apparatus in the building.

The building also contains a 5-inch Kennedy meter for measuring the flow of water to the Cransley works; an automatic throttle valve for shutting off the water in the event of a pipe bursting in the delivery main between the two reservoirs; the ram for the Thorpe supply, and a 1-inch Kennedy meter for measuring that supply. Under the floor is a clear water tank for the water from the filters, of a sufficient capacity to hold one day's supply for Thorpe.

The two small filters and the clear water tank are constructed of concrete and rendered. The filters are each 16 feet by 12 feet; drain tiles, 2 inches diameter, are laid close together on the floors to form drains delivering into the centre channels. One-inch granite chippings are spread and levelled over these to form a floor 6 inches above the highest level of the concrete floor, which has a cross fall of 2 inches to the centre drain, and on this is spread a layer of ½-inch granite, 3 inches thick, and then a bed of Leighton Buzzard sand, 2 feet thick, well consolidated. All materials will be well washed before being placed in the filters. The filters will be worked alternately, and a small sand washer is provided for cleaning the sand.

The supply to the filters is by a 3-inch pipe from the 12-inch main for Cransley. It will be automatically regulated by an equilibrium ball-valve at the delivery end of the supply pipe working in a small tank close to the filters, and adjusted to maintain a depth of 2 feet of water over the sand. The filters will obtain their water from the ball-valve tank, and are provided with overflows, but the filters and clear water tank have the same water level as the ball-valve tank, so that the water level throughout will be automatically controlled by the ball-valve, and no attention beyond an occasional inspection will be required for working either the hydraulic ram or the filters.

Loddington Drainage.

To protect the water of the reservoir from contamination by the drainage of the village of Loddington on the watershed about a mile above the embankment, a drain has been laid commencing 9 inches diameter at the upper end below the village and increasing to 12 inches at the first cross road, which size is continued for the remainder of its length. It enters the reservoir site near the upper end and runs just above top water level till it crosses the line of puddle wall, when it turns down the hillside and delivers into the waste water channel just within the boundary of the site. The drain is of glazed stoneware pipes, the 12-inch pipes having Hassall's single joints, and the 9-inch Stanford joints; a 12-inch iron pipe is provided for crossing the puddle wall, with a puddle flange to prevent any creeping of water through the puddle.

The total length of the drain is 2405 yards; the gradient

above the embankment is 1 in 270, and an automatic siphon flushing chamber of 500 gallons capacity and fed with spring water is placed at the upper end. The depths vary from 2½ feet to 16 feet, the average being 8 feet 3 inches, and the cost of construction was 1607*l.* 14*s.* 7*d.* Compensation paid to the owners of land passed through has been about 1*s.* 6*d.* per yard lineal for grass land, and 3*s.* per yard lineal where ironstone lay under, and to tenants from 5*s.* to 10*s.* per chain.

Delivery Main.

The water from the Thorpe reservoir is conveyed to the Cransley works for filtration and pumping by a 15-inch main, 4050 yards in length, which is laid down the valley below the new reservoir to its junction with the valley in which the Cransley reservoir is situated, when its course turns up to these works, when it delivers the water into the reservoir just beyond the southern end of the embankment. As the overflow level of the new reservoir is 335 feet above O.D., and of the Cransley reservoir 298·5 feet above O.D., there is a good head to force the water round. A connection is also made with the main supplying the filters at the foot of the Cransley embankment, so that the Thorpe water can be delivered direct to the filters without entering the Cransley reservoir, if desired. This 15-inch main is designed to also convey the water from the Orton reservoir when constructed, and has been carried under the bridge over the waste water channel and just clear of the bridge abutment, where the end is capped, so that it may be conveniently continued when required. A junction near this bridge receives the water from the present works. Wash-out valves are provided on the main at its lowest point where crossing the brook at the turn to Cransley, and from this point there is a continual rise in both directions—towards Cransley reservoir and towards Thorpe reservoir—so that no air valves have been required.

This main was laid in 1902 and 1903 by direct labour without a contractor. The pipes were supplied by the Sheepbridge Coal and Iron Co., Ltd. They are each 12 feet long exclusive of socket, $\frac{11}{16}$ inch thick, sockets 4½ inches deep with ⅜ inch lead space; the weight of each pipe is 12½ cwt. All pipes were tested at the works to a pressure of 600 feet, and

again to about half this pressure by a portable hydraulic pump when laid and jointed in the trench. The maximum pressure on the main at its lowest point under present conditions will be 98½ feet, which will be increased to 123½ feet when the Orton reservoir is connected. The joints were made with a gasket of $\frac{5}{16}$ inch diameter rod lead instead of yarn, and then run and jointed in the usual way, each joint taking about 56 lb. lead. The trench was deep enough to allow of 3 feet of cover over the pipes, the usual depth being 4 feet 6 inches, any low places in the ground being filled up to give the cover required. The main, except for road crossings and one field, is laid through grass land.

The cost of the main was as follows:—

	£	s.	d.
Straight pipes, at 4*l.* 16*s.* 8*d.*, per ton, 2*l.* 19*s.* 3*d.* each	2,980	5	6
Specials, at 9*l.* 9*s.* per ton	65	9	1
Valves	27	11	3
Lead	163	10	7
Carting pipes, etc., at 4*s.* per ton	133	10	0
Carting on trench work	46	18	7
Labour in trench work and laying and jointing pipes	671	8	11
Inspecting and testing pipes at Sheepbridge and at Kettering station	62	7	4
Miscellaneous	57	10	3
Total	£4,208	11	6

Compensation paid to owners of land passed through has been about 1*s.* 6*d.* per yard lineal, and to tenants about 10*s.* per chain.

Filters.

Among the works sanctioned by the Council's Bill are additional filters at the Cransley works as they become necessary. When the works were taken over by the Council there were three filters each 500 square yards in area, and as the daily consumption continued to increase the rate of filtration soon became close on to 3 gallons per square foot per hour for two filters working, so that it was thought wise to increase the filtration area by adding another filter. For convenience in working the same area of filter was adopted, and the ground adjoining the existing beds was laid out for four new filters, one of which was then constructed.

The details of construction differ somewhat from the three old beds. These have each a centre drain fed by side drains,

10 feet apart, surrounded and covered by rubble filling to a depth of 2 feet, with two layers above of 1 inch and $\frac{1}{2}$ inch granite, each 6 inches thick, the latter covered by a bed of sand 2 feet thick, the depth of water above being 2 feet. Ventilators are taken up through the sand bed from the head of each side drain.

The new bed is constructed of burnt ballast concrete, mixed 6 parts ballast with some sand, and 1 part cement, faced with Hamblet's best pressed blue bricks in cement mortar above the sand bed, and with local red wire-cuts below. The face of the walls has a batter of 1 in 8. The clay for ballast was dug and burnt on ground adjoining, the ballast being broken to a gauge of 2 inches and smaller, and thoroughly soaked with water before using. The floor is of concrete, 9 inches thick, rendered, and the concrete walls are well backed with clay puddle, 18 inches thick, taken down and well keyed into the natural bed of clay on which the filter stands. A hollow floor of common bricks on edge covered with common bricks laid flat is formed on the concrete floor, which has a cross-fall of 3 inches from the longer sides to a central drain sunk in the concrete, the bricks on edge of the hollow floor forming cross drains delivering into the central drain. Above the hollow floor a level bed is formed of washed gravel about 1 inch to $\frac{3}{4}$ inch gauge, 6 inches thick above the highest part of the floor; on this finer gravel, $\frac{1}{2}$ inch to $\frac{3}{8}$ inch gauge, is spread 3 inches thick, and on this a bed of Leighton Buzzard sand 2 feet thick. The sand was well washed and placed in the bed in layers well consolidated by ramming, special care being taken to ram it tight against the side walls to prevent water creeping down without filtration, and the battered face of the walls was intended to insure that any settlement of the sand would only force it closer to the wall and so assist in preventing creep. No ventilators are brought up from the hollow floor through the sand, as it is very difficult to keep the sand tight against them, and the Author considered that the sand itself would sufficiently allow of the passage of air when filling and emptying the beds. Ventilators have, however, been formed in the concrete walls from both ends of the main drain, the ventilator at the lower end being particularly useful in preventing any accumulation of imprisoned air in the small chamber in which this drain terminates. The working depth of the water above the sand is 2 feet.

The old beds were originally fed from a channel through

sluices, so that it was impossible to judge of the quantity of water entering, and as there is no clear water tank, only a small well from which the pumps take their suction and in which the water stands level with the water in the filters, there was no means of knowing what work each filter was doing. When the new filter was constructed this arrangement of feed was altered; a 12-inch main was laid round with 9-inch branches to the filters delivering into small tanks, from which the water enters the filters over sheet-iron weirs so that it can be gauged.

The construction of this filter was carried out by direct labour without a contractor, and amounted to 1242*l.* 14*s.* 2*d.*, and the cost of the alterations in the water service to the old beds was 366*l.* 6*s.* 2*d.*, making a total expenditure on the filters of 1609*l.* 0*s.* 4*d.*

Subsidence of Embankment.

The construction of the Thorpe Reservoir was commenced in September 1903, and should have been completed by the end of March 1905, but the work was much delayed by the wet season following commencement. It would have been completed early in August but for a subsidence of part of the embankment between the valve tower and the south end, which occurred at the end of May last. The embankment was then within about 7 feet of its finished height; the lower portion of the outer slope had been roughly soiled, and on the inside slope some 1500 yards of stone pitching had been placed on the lower portion of the south end.

The first thing noticed was a local settlement of the puddle wall, which began to attract attention about the beginning of the last week in May, and at the same time the pitching began, apparently, to travel down the slope of the embankment and crumple at the foot. This continued during the week, and by the end the surface of the puddle wall had sunk about 5 feet, the inner slope had bulged outwards considerably, and several cracks appeared parallel to the line of the embankment for the length of the subsidence, but considerably transverse to this line towards the ends, and on the Saturday it was also evident that the ground immediately at the foot of the embankment on the inside was moving and crumpling up under the pressure of the weight of the embankment. As these movements continued to increase, the Water Committee, at a special meeting on the site

the following Monday, considered it would only be wise to take further advice, and instructed the Author to consult with Mr. Geo. R. Strachan, M.Inst.C.E., as to the best course to pursue.

The portion of the embankment affected by the subsidence was a length of 250 feet between points 250 feet and 500 feet from the south end. In order to determine the nature of the movement at the foot of the inner slope, four lines of pegs, 4 feet long, were driven into the ground, the first row near the foot of the slope, the second 10 feet away from the first, the third 30 feet, and the fourth 60 ft., the rows being set out parallel to the centre line of the embankment. Observations had already been taken of the movement of the puddle wall, but a centre line of pegs was now put in, and another line at the foot of the outer slope, as this side had bulged slightly, though no movement had been noticed at the foot. The pegs were accurately lined and levelled, and observations were taken on the 31st May and 1st, 3rd, and 5th of June. By this time the puddle wall had sunk another foot at the central part of the subsidence, making a total of 6 feet, and had moved inwards 5⅝ inches, making a total movement inwards of about 18 inches. At the foot of the inner slope the pegs in the first line where opposite the central portion of the subsidence had travelled from 8 inches to 11 inches up stream, in the second line from 5 to 6 inches, and in the third and fourth lines from ½ inch to 1 inch; the general line of movement being not square to the embankment, but somewhat on the skew, away from the steep side of the valley at the south end and towards the centre line of the reservoir. There was also some alteration in the level of the pegs.

It appeared from these observations that the ground was giving way under the pressure of the embankment and moving bodily up-stream, and to stop the movement and secure the embankment Mr. Strachan advised that a line of piles be driven for a length of about 200 feet parallel to the foot of the slope and about 20 feet away from it, and that a heavy toe be formed over the ground extending about 25 feet beyond the piles and about 15 feet thick, and that from this platform a new inner slope be formed against the original bank with a slope of 1 in 4.

No movement was observed for some time on the outer portion of the embankment, and it was therefore only proposed to add weight to it by flattening the slope below the 4 foot berm

to 1 in 3½. Later there was a slight movement opposite the central portion of the subsidence, and it was decided to drive a row of close piling for a length of about 180 feet on this side also to insure the safety of the bank. The whole of the piles have since been driven and the alteration to this part of the embankment is now well in hand.

The observations on the lines of pegs were continued till June 21 when the pegs were disturbed by the progress of the works. At that date the puddle wall in the central portion of the subsidence had sunk from 2 feet 6 inches to 2 feet 9 inches since the pegs were put in, making a total subsidence of 7 feet 6 inches to 7 feet 9 inches, and at the foot of the inner slope the movement in line 1 had increased to 19 inches and in line 2 to 9 inches, but there was no further movement in lines 3 and 4.

The general contractor for the works is Mr. F. Barlow, of Rothwell, near Kettering. The Author has been well assisted in carrying out these works by Mr. W. C. Holloway, who has prepared the plans and acted as resident-engineer on the works.

By the courtesy of the contractor the Author is able to give the following prices for the principal items in the contract for the embankment:

	£	s.	d.	
Excavation for puddle trench from ground level to top of clay, depths from 3 ft. to 15 ft., average 7 ft. 6 in.	0	1	6	per yd. cub.
Ditto from top of clay to bottom of trench, as shown on drawings, depths 9 ft. to 18 ft. below surface, average 12 ft.	0	2	0	„
Ditto below this, but not exceeding 18 ft. below surface	0	2	6	„
Ditto below this, but not exceeding 25 ft. below surface	0	2	6	„
Clay puddle in trench below ground level, material obtained from excavations for the work	0	2	6	„
Ditto in puddle wall above ground level, from special excavations	0	3	0	„
Stripping site of embankment to depth of 1 ft. ..	0	0	4	per yd. sup.
Forming embankment with material obtained from excavations for works	0	0	1	per yd. cub.
Ditto from special excavation, price to include cost of obtaining materials	0	1	3	„
Extra on selected material next the puddle wall ..	0	0	2	„
Pitching inner slope with local stone, 6 in. deep on 6 in. of rubble	0	4	6	per yd. sup.
Ditto, but with stone 9 in. deep	0	5	0	„
Ditto, but with stone 12 in. deep on 9 in. of rubble	0	5	6	„
Soiling outer slope	0	0	4	„

	£	s.	d.	
Brickwork of horseshoe culvert in two half-brick rings in cement mortar, 1 part cement to 2 parts sand, with ½ in. rendering between, including all centering	0	6	0	per yd. sup.
Extra only over common wire-cuts for lining inside of culvert with best blue brindled bricks with radial joints	0	3	0	"
Cement concrete, broken brick ballast, 4 to 1, surrounding brickwork of culvert, including all moulds, templates, etc.	1	5	0	per yd. cub.
Ditto, with granite ballast	1	7	6	"
Ditto, ditto, in walls of base of tower, including all timbering	1	7	6	"
Ditto, ditto, but 3 to 1, in octagonal part above square base	1	12	6	"
9 in. reduced brickwork of blue brindles in cement mortar of cement and sand in equal parts, in outer face of tower	0	11	0	per yd. sup.
Derbyshire stone coping to tower, 12 in. thick, tooled all over	0	6	3	per ft. cub.
Cement concrete in floor of fore-bay to tower, brick ballast, 5 to 1	1	2	0	per yd. cub.
Ditto in side walls, including all timbering	1	8	6	"
Excavation for waste water channel and overflow weir	0	1	6	"
Cement concrete for tongue of weir, granite ballast, 4 to 1	1	7	6	"
Ditto, brick ballast, 6 to 1, foundation of side walls of channel	1	5	0	"
Ditto, granite ballast, 4 to 1, in kerbs of steps in floor of channel	1	10	0	"
Ditto, brick ballast, 6 to 1, in floor of channel, 6 in. thick	0	5	0	per yd. sup.
Ditto granite ballast, 4 to 1, on upper part of floor of channel spread 3 in. thick	0	3	3	"
Extra for dishing floor of lower part of channel, including additional concrete	0	1	0	"
Rubble walling in cement mortar, 1 to 2, to sides of channel, average thickness 2 ft.	0	15	0	"
Extra where built circular	0	1	0	"
Derbyshire stone in overflow weir	0	6	8	per ft. cub.
Best pressed blue Staffordshire double bull-nosed coping bricks, 14 in. by 6 in. by 6 in., set and jointed in cement mortar	0	1	9	per ft. lin.
Roads of local stone, foundation 4 in. thick of 2 in. to 4 in. gauge, covered with 3 in. broken to 1½ to 2 in. gauge, rolled with 2-ton horse roller, total thickness 7 in.	0	1	3	per yd. sup.
Unclimbable wrought iron fencing, 5 ft. 6 in. high, upright bars ⅝ in. sq. fixed diagonally 4½ in. apart centres, standards and rails 1⅝ in. by ⅜ in.	0	9	8	per yd. lin.
Baltic fir piles, 12 in sq., 18 ft. long	0	2	2	per ft. cub.
Driving same, measured on length driven	0	1	2	"
Cast shoes	0	4	0	each.

The following statement gives the contracts let and othe expenditure in connection with the Thorpe Malsor Reservoir:-

	£	s.	d.
Purchase of land for site of reservoir (59 acres 3 rods 5 poles = about 142*l*. per acre)	8,522	6	6
Reservoir embankment, not including additional work due to subsidence	15,800	0	0
Draw-off valves, etc., other valves and sand washer	282	2	0
Meter, automatic valve and hydraulic ram	127	15	0
Automatic gauge recorder for compensation water	23	0	0
Cast iron pipes	259	8	8
Loddington drainage	1,607	14	7
Road culverts	463	13	8
15-in. delivery main	4,208	11	6
Cottage	400	0	0
	£31,694	11	11

ELECTRIC LIGHT AND POWER STATION AND REFUSE DESTRUCTOR AT KETTERING.

By THOS. READER SMITH.

It is now some ten years since the Kettering Urban Council first considered the advisability of providing an Electric Light and Power Installation for the town, and decided to apply to the Board of Trade for a provisional order, which they obtained in 1896. Owing to other heavy expenditure before them, however, they felt they could not at that time proceed with the works, which were from time to time postponed, and it was not till May 1899 that Dr. Kennedy was engaged to report on the works required for an installation and the prospects of such an undertaking in Kettering. This report was received in January 1900, and it showed that, while there was every likelihood of such an undertaking being successful, the Council would have to be prepared for a capital expenditure of about 40,000*l.*

The probability of the undertaking ultimately proving very remunerative was fully borne out by the eagerness displayed by several companies to purchase the Council's provisional order and establish works themselves; and the difficulty of meeting the initial expenditure of capital, and of further supporting the undertaking for the first two or three years until it paid its own way, led the Council to seriously consider the offers of companies who proposed various schemes by which the works should be constructed and the installation run by themselves for a term of years, when the Council would have the option of taking the works over on terms to be agreed upon, and the representatives of a number of these companies were interviewed. The proposals received were shortly as follows:

(*a*) A company would construct works and conduct the undertaking, the Council having the option by a two years' notice in writing requiring the company to sell the undertaking, of purchasing them, at the end of seven years from the date of the company commencing to supply electricity, and within six

months of any subsequent period of seven years at their value as a going concern; or for a sum equal to the capital expenditure, plus 33⅓ per cent.; or if the purchase was not made at the end of the first term of seven years, at a premium of 20 per cent.

(b) A company, in the event of their tender for a considerable section of the work being accepted, and the Council agreeing to pay them a percentage to cover risk and trouble, offered to run the installation for five years and then hand it over to the Council as a going concern. The Council were to construct the works, the company having a voice in the selection of the site, the extent of the initial scheme, and amount of capital expenditure; the company would then pay the Council, during the term of five years, the sums required for repayment of capital with interest as they became due. The Council to give the company a substantial amount of street lighting; the company to receive the whole of the revenues, and they would work the destructor and destroy all refuse.

(c) A company would take over the Council's provisional order, refunding the Council the expense incurred in obtaining it. The company would construct the works and conduct the undertaking, the Council having the option of purchasing them at any time after ten years' working by paying a sum equal to the capital expended plus 15 per cent., and a further sum if required to make the company's dividends for the period average 6 per cent.

(d) The Council to provide the capital required, but the company to purchase all plant and establish the works and take all revenue for seven years, at the same time refunding the Council the sums required for repayments of capital with interest as they become due. The Council to have the option of taking over the works at the end of that period on payment to the company of a premium amounting to 10 per cent. of the capital expenditure, or at the end of fourteen years without premium.

(e) A company would find all capital, construct all works, and conduct the undertaking, the Council having the right of purchase by valuation at any time after ten years' working.

As the Lighting Committee of the Council investigated these various proposals, a number of objectionable features became apparent; only in one case were the works to be constructed and plant purchased by the Council, and then they were not to have a free hand.

In other offers the companies would construct the works, for which, however, in one case the Council were to find the capital; they would prepare their own schemes, and while a certain amount of supervision would be allowed the Council through their engineer, it became evident that they would have practically no control over the design of the station or selection or manufacture of the plant they would intend to take over after a term of years.

In some cases, whatever voice the Council might have in the first stages of the installation, they would have practically none in matters of extension and of additional machinery or plant.

In all cases the Council would only be able to acquire the undertaking at a heavy premium in some form or other, generally as a percentage on capital expenditure, but also probably in the high initial cost at which all plant and machinery would be valued, as with works constructed by a company the Council would lose all the advantages of open tendering, and plant and machinery purchased in this way might not be such as the Council would have selected themselves.

After giving these various proposals a very full consideration, the Lighting Committee came to the conclusion that it would be in the best interests of the town for the Council to construct the works themselves, and conduct the undertaking from the commencement, and they so advised the Council, who instructed Dr. Kennedy to complete his plans and estimates with a view to proceeding with the works.

The scheme proposed included the provision of a refuse destructor to work in connection with the electricity works. Like the electric light, the question of providing a destructor for dealing with house refuse had been for some years more or less under consideration. The increasing difficulty of finding a tip where the refuse could be disposed of without nuisance, and the expense of carting to the only place available in the neighbourhood, 2¼ miles from the centre of the town, made it urgent that something else should be done.

After considering the relative advantages of putting the destructor at the sewage disposal works, or building it in connection with the electricity works, it was decided to adopt the latter course. A site had been provisionally secured near the centre of the town, 7377 square yards in area, sufficiently large for an electric light and power station and refuse destructor

combined, and also for public baths to be erected at a later date; the site would also allow of considerable enlargement of the initial installation, and there was land adjoining which could be secured for further extension when this should become necessary. The cost of carting refuse to a destructor on this site would necessarily, by reason of its position, be a minimum, and the whole of the steam raised by the waste heat from the combustion of the refuse would easily be utilised by the electricity works. Dr. Kennedy was asked, therefore, to prepare his plans for a combined scheme, and the Author was instructed to advertise for tenders for providing and erecting a refuse destructor.

In particulars issued to guide persons tendering, the population was put at 30,000, and the amount of refuse per week at 100 tons. As the destructor was to be erected in the centre of the town, it was stated to be essential that its design and construction should be such as would insure the complete destruction of refuse at a high temperature and without causing any nuisance. The destructor was to be capable of destroying 100 tons per week with a proper margin to meet the growth of the town. The plant was to be suitable for erection in connection with an electric light and power station, and for raising steam in a Lancashire boiler to work with the station boilers, blowing off at 160 lb. per square inch. Tenders were to include for destructor furnace with hopper, boiler setting and flues, etc., but not buildings or boiler or steam piping, and for supplying and erecting the plant complete. Tenders were also to include for working the destructor for six months after completion, for maintaining the plant during that period, and handing it over to the Council in proper working order at the end of that time, and certain guarantees were asked for with reference to the performance of the plant.

Nine tenders were received in response to the Council's advertisement; and the committee, after carefully considering the various proposals made, and visiting a number of destructors at work, finally recommended the Council to accept the tender of Messrs. Meldrum Bros., amounting to 1931*l.* 10*s.*, as, although not the lowest, it appeared to be the best suited to the Council's requirements.

When the Council decided to proceed with the electricity works, the Author was instructed to prepare plans for buildings

designed to Dr. Kennedy's general plan, and to meet his requirements as to dimensions, levels, and other details.

The site many years ago was quarried over for stone for local buildings, the workings being 12 feet to 14 feet deep in places, so that the foundations of the heavier buildings had to be taken down to a considerable depth; as, however, the floors of the engine house and boiler house basements are 8 feet and 5 feet 6 inches below ground, the additional depth required was not excessive. There are two entrances to the site, one from Field Street on the west, serving the boilers and refuse destructor, and one from the Rockingham Road on the east side, which will be more used in connection with the offices and electrical part of the work. As deep drainage was necessary to meet the requirements of the baths proposed to be erected on part of the site, and a dry basement for the engine and dynamo room was essential for electrical considerations, the buildings have been surrounded with a ring of deep drains, broken only by the chimney foundation, of stoneware pipes with the upper half of the joints left open and the trench immediately above filled in with rubbly material so that no water from the surrounding ground, which the filled-in quarry workings have left very porous, can cross the trenches to the buildings. This was done from the Field Street entrance on the west side, where a connection was made with the surface water drainage system, which thus discharges all ground and surface water into the brook on the west side of the town.

The buildings are of local red wire-cut bricks with dressings of pressed bricks and stone, the roofs being slated or glazed. The principal building of the block is the engine and dynamo house. It is about 100 feet long inside and 39 feet 6 inches clear width between piers. The height from floor to tie-rods of roof principals is 28 feet, which gives a good headroom for the travelling crane which runs the length of the building 20 feet above floor level. The basement is 8 feet deep below floor level; it contains the engine bed, steam exhaust pipes, and electrical cables. The engine bed is a solid block of concrete of broken brick ballast with sand and Portland cement, mixed 6 to 1, and measures 37 feet 6 inches by 24 feet, and has a total depth of 14 feet, having to be taken down 6 feet below the basement floor to get to a solid foundation. To save expense the part below the basement floor was made with Barrow lias lime instead of

Portland cement. Steel tubes were embedded in the concrete through which the cables pass from the dynamos. The engine bed stands well away from the walls of the building, so as to leave ample room between for steam exhaust pipes and electrical cables and leads to switchboard; on the east side, where the cables are, the space is 11 feet 8 inches wide, and is floored over with concrete arches on 7-inch by 3¾-inch steel joists, spaced 4 feet apart centres; and on the south and west sides, where the spaces are narrower, the flooring is of $\frac{5}{16}$-inch rolled steel chequered plates on 4-inch by 3-inch steel joists. The surface of the engine bed and the concrete flooring is finished with terrazzo paving.

Only about half the floor space is at present occupied by machinery, the remainder, between the engine bed and the main entrance at the north end, being left for additional machinery when required, and boarded over. A strong timber stage has been erected from the basement floor immediately inside the main entrance to receive railway drays with heavy loads, which are dealt with from this point by the travelling crane.

The walls on the inside are faced with local red facing bricks with a dado of glazed bricks 5 feet high all round. They are divided into bays by piers supporting the crane rail girders and panelled with arches up to this level, and there are clerestory windows in bays above, which, with the roof glazing and large end windows, afford ample lighting.

The switchboard platform is placed alongside the east wall of the engine house adjoining the battery room; it is raised 3 feet 6 inches above the engine house floor, and is 49 feet long by 11 feet wide. It is formed of a flat slab of concrete, 6 inches thick, placed on 7-inch by 3¾-inch steel joists spaced 4 feet apart centres, so as to leave the full depth of the joists free for all attachments required for leads from the cables to the switchboard. A rolled steel channel, 6 inches by 4 inches, bolted to cast shoes fixed to the steel floor joists, forms the foundation for the switchboard. Steps from the engine house floor lead up to the platform, and a small staircase from a balcony over the entrance to the engine house from the offices gives ready access from the chief engineer's office on the first floor.

The office block and battery room are on the east side of the engine house. The former comprises the public entrance, general office, stores, engine-driver's room and lavatory on the

ground floor, with chief engineer's and assistant engineer's offices, drawing office, lavatory, and meter room on the first floor. The length of the office block is 54 feet, and the depth 26 feet 6 inches. The battery room measures 46 feet 8 inches by 25 feet inside, and is 12 feet in height to the roof tie beams. On account of the acid fumes from the accumulators, the roof has been made of timber, and all timber and iron work has been painted with acid-proof paint, and the floor paved with acid-proof asphalt.

The boiler-house is placed alongside the engine-house on the west side; it is the same length, and has a total width, including coal bunkers, of 66 feet; the floor level is 5 feet 6 inches below the engine-house floor, and the height from floor level to the ties of the principal roof is 20 feet. The east side of the block is constructed of steel stanchions filled in with revolving steel shutters; these open on to the coal bunkers, one to each boiler, which are filled direct from carts over a strong tipping beam fixed the full length of the building. The roofing over the coal bunkers is of galvanized corrugated iron sheets on angle purlins, and any part of the roofing and stanchions can readily be removed to admit a new boiler.

Three boilers only are fixed at present, but there is accommodation for four more in the present building. They are of the Lancashire type, 8 feet diameter and 28 feet in length; the flues are arranged in the usual way with side flues delivering into the main flue at the back; Poulton's blocks have been used throughout for seating and covers.

The main flue runs alongside the basement wall of the engine-house with a cavity between; it measures 8 feet high by 5 feet wide. On leaving the boiler-house the flue bends round towards the chimney and is widened out to form three parallel flues, a by-pass up the centre and a flue on either side—only one of which has been constructed at present—for feed-water economisers. A connection from the refuse destructor flue has been made with this side flue, so that the hot gases from the destructor may be available for heating the economisers. The flues throughout are lined with firebrick; the entrances and connections are controlled by cast-iron swivel dampers, and the flues are covered with cast-iron ribbed plates covered with sand and paved over with concrete slabs.

The refuse destructor buildings are well removed from the

engine-house; they adjoin the south-west corner of the boiler-house, a small door in the south wall of the latter opening into the destructor boiler-house being the only communication between them. The destructor building and boiler-house are 78 feet in length by 49 feet in width. The tipping floor of concrete arches on steel joists is immediately over the furnace and firing floor; it is paved with 3-inch granite cubes, and measures 50 feet by 26 feet and is 11 feet 6 inches in height to the tie rods of roof principals. Access to the tipping floor is by an inclined road, with a gradient of 1 in 18, along the west boundary of the site commencing at the Field Street entrance. Refuse is tipped from carts into a large hopper with an opening below along the front from which the refuse is hand fed into the furnaces immediately opposite.

As owing to the requirements of the electric light station it was impossible to place the furnace facing the open yard, access for carts to the firing floor has been provided by an entrance from the clinker yard behind, through the destructor boiler house, and the buildings and plant have been so arranged that room is left for an exactly similar plant between this entrance and the south boundary of the site, so that the complete plant would consist of two similar furnaces with their boilers symmetrically arranged with the cartway up the centre between them.

The destructor is one of Messrs. Meldrum Bros. patent simplex regenerative furnaces of the front feed type, the front feed being adopted in preference to top feed, as the refuse is kept cooler in the hopper, well away from the furnace while awaiting destruction, and so is less liable to become offensive, and the stoking can be more efficiently done by hand through the front furnace doors than from a top feed hole. The furnace has two grates, space being left for the enlargement of the furnace to a three-grate cell. It measures 12 feet by 6 feet 2 inches between walls, and 10 feet by 5 feet 2 inches over the grates, and is guaranteed to effectually destroy 25 tons of refuse in 24 hours, or 17 tons in 16 hours working normally. The combustion chamber is 13 feet by 5 feet 11 inches and 10 feet high; it is practically a continuation of the furnace which it immediately adjoins, only being separated from it by a low fire-brick bridge. A minimum working temperature of 1400° F. and an average working temperature of 1700° F. are guaranteed for the com-

bustion chamber, and no difficulty is found in maintaining these temperatures, higher temperatures being frequently reached, considerable quantities of dust being fused on the floor of the chamber.

From the combustion chamber the hot gases from the furnace pass through the flues of an 8 feet by 28 feet Lancashire boiler, working at a pressure of 200 lb. on the square inch, to a horizontal chamber in the rear, from which they pass through a regenerator consisting of 176 3-inch diameter cast-iron pipes to the main flue below; the air feed for the furnace circulating between these pipes is raised to a temperature of about 350° F., and is led by a special flue to chambers under the furnace grates, each of which is fitted with two of Meldrum's steam blowers, by which forced draught is supplied to the furnace. The main flue from the boiler passes direct to the chimney and has a connection on the way, as stated above, to the economiser flue; a by-pass flue takes the gases from the combustion chamber into the main flue beyond the boiler when the latter is shut down, and a special door beyond the combustion chamber admits an air feed into the by-pass to cool the gases down for use with the economiser.

As details of the working of the destructor are given elsewhere, it is sufficient here to say that it has worked well from the commencement in May last year, that there is no difficulty in obtaining and maintaining good temperatures in the combustion chamber, and that, though situated in the centre of the town in a closely built district, it does not give rise to any nuisance.

The roofs of the buildings throughout, except the offices and battery room, are of mild steel; ventilators run the full length of the buildings; the upper parts of the roofs and ventilators are glazed with Helliwell's patent glazing, and the sides of the ventilators are filled in with Helliwell's zinc louvres. The drawings give all details, and the Table on p. 136 gives the sections used in the various principals.

The chimney stands at the south-east corner of the block. It has an octagonal shaft and square base; its clear diameter inside is 9 feet and its height is 150 feet above ground level. It stands on a concrete foundation 30 feet square by 7 feet 6 inches thick, the base resting on the solid blue clay 14 feet 6 inches below ground level. The sides of the square base

Dimensions of Roof Principals.

	Span.	Distance Apart.	Principal Rafters.	Struts.	Tie Rods.	Tie Bolts.	Purlins.
Engine house ..	41′ 0″	14′ 0″	4″ × 5″ × 1/2″ tees	{ 4″ × 4″ × 1/2″ ; 3″ × 3″ × 3/8″ } tees	1 3/4″, 1 1/2″ dia.	1 3/8″, 1″, 3/4″ dia.	7″ × 3″ Z section, 16 lb. per ft.
Do. ventilator ..	13′ 6″	14′ 0″	3″ × 3″ × 3/8″ ,,	2 1/2″ × 2 1/2″ × 1/4″ ,,			
Boiler house ..	38′ 4″	11′ 9″	4″ × 4″ × 1/2″ ,,	{ 3 1/2″ × 3 1/2″ × 3/8″ ; 3″ × 3″ × 5/16″ } ,,	1 1/2″, 1 1/4″ ,,	1 1/8″, 7/8″, 3/4″ ,,	{ 5″ × 3″ do., 13·05 lb. per ft. ; 4″ × 3″ ,, 11·78 ,, }
Do. ventilator ..	13′ 0″	11′ 9″	3″ × 3″ × 3/8″ ,,	2 1/2″ × 2 1/2″ × 1/4″ ,,			
Do. Firing floor	13′ 9″	11′ 9″	3″ × 3″ × 5/16″ ,,	.. ..	3/4″ ,,	3/4″ ,,	4″ × 3″, do. do.
Do. Coal bunkers (lean-to)	13′ 8″	11′ 9″	3″ × 3″ × 5/16″ ,,	3″ × 3″ × 5/16″ ,,	.. ..	.. ..	3″ × 3″ × 3/8″ angles.
Destructor	25′ 6″	9′ 0″	3″ × 3″ × 3/8″ ,,	{ 2 1/2″ × 2 1/2″ × 5/16″ ; 2″ × 2″ × 5/16″ } ,,	1 1/4″, 1 1/8″ dia.	1″, 3/4″, 5/8″ dia.	4″ × 3″ Z section.
Do. ventilator ..	8′ 0″	9′ 0″	2 1/2″ × 2 1/2″ × 1/4″ ,,	2 1/2″ × 2 1/2″ × 1/4″ ,,			
Do. boiler	21′ 0″	8′ 10″	3″ × 3″ × 5/16″ ,,	2″ × 2″ × 5/16″ ,,	2″ × 1/2″, 2″ × 3/8″ flat bars.	2″ × 3/8″ flat bars.	4″ × 3″ Z section.
Do. ventilator ..	6′ 6″	8′ 10″	2 1/2″ × 2 1/2″ × 1/4″ ,,	2 1/2″ × 2 1/2″ × 1/4″ ,,			

measure 19 feet 9 inches in length, and 21 feet 3 inches in height from the ground to the top of the cornice, above which the square base is gathered in with pyramidal corners, all faced with plinth bricks, to the octagonal shaft above. The sides are formed with arched panels.

The shaft is built in sections of 25 feet in height, the thickness of the brickwork of the lower part of the octagonal shaft being 2 feet 7½ inches, each successive section diminishing 4½ inches in thickness by set-backs on the inside to 13½ inches, the thickness of the top section. The batter on the outside of the octagonal shaft is 1 in 45. Hoop-iron bonds are used to strengthen the top section, two rows of 1½-inch by $\frac{1}{16}$-inch hoop-iron being used on each side every sixth course, the ends being interlaced at the corners and turned down into the joints of the brickwork.

The top is finished with a cast-iron cap made in sixteen sections, bolted together and secured to the brickwork below with holding-down bolts; the outer face of the cap is shaped to a curved splay, which is continued below by specially made blue-brick blocks well bonded together, and the whole is placed on a blue-brick cornice carried on red arches springing from piers corbelled out from the octagonal corners of the shaft.

The chimney is built with local red wire-cuts in Barrow lias lime mortar, with an outer facing of Leicestershire Heather bricks; the cap only is built with Portland cement mortar. The shaft is lined for half its height with firebrick set in fire-clay, the bottom portion in the square base being 9 inches thick, and the octagonal part above 4½ inches thick; a cavity is left between the firebrick lining and the red brickwork of the shaft, which is ventilated by a current of air from cast-iron gratings in the base.

A cast-iron steam exhaust pipe, 20 inches diameter, is taken up the centre of the chimney for the full height of 150 feet. It stands on a cast-iron stool-piece at the bottom, which takes the whole weight, and is steadied at intervals of 18 feet up the shaft by cast-iron arms resting on the brickwork, but left free to move under expansion when heated. A junction and valve are provided at the foot, from which steam will be taken across to heat the baths when these are erected.

A copper tape lightning conductor, 1¼ inch by ⅛ inch, is fixed up the shaft, terminating at the top in a 2 inch by ¼ inch

copper coronal fixed to the cast-iron cap and with four copper points screwed in, and at the foot in an earth plate, 2 feet by 3 feet, buried about 6 feet deep.

The total weight of the structure, including the 20-inch steam exhaust, is about 1800 tons, which gives a pressure of 2 tons per square foot on the blue clay immediately below the concrete foundation block.

The cost of the various works described has been follows :—

ELECTRIC LIGHT AND POWER STATION.

Buildings.

	£	s.	d.
Purchase of site, 3985 sq. yds.	1,401	6	10
Drainage of site	355	14	8
Buildings	6,194	19	6
Roofs	442	2	0
Fencing, north side of site	41	11	6
Economiser roof	78	15	0
Electric lighting of buildings	286	0	0
Furnishing offices and stores	121	2	3
Work done by Council—road making, drainage, etc., labour, materials, and carting	203	18	1
Miscellaneous—Clerk of Works, Quantity Surveyor, printing and advertising, legal expenses, etc... ..	473	11	1
	£9,599	0	11

Chimney.

Foundation	342	16	3
Chimney shaft	1,124	11	5
20 in. steam exhaust up centre (cost of pipes and stays)	130	3	6
	£1,597	11	2

Total £11,196 12 1

REFUSE DESTRUCTOR.

	£	s.	d.
Purchase of site, 1600 sq. yds.	495	0	10
Boundary wall	35	1	7
Buildings and inclined road	1,875	15	9
Roofs	123	14	3
Refuse destructor	1,625	0	0
Boiler setting and flues	329	17	0
Boiler and connections	888	5	4
Road making, etc., done by Council—labour and materials	74	19	2
Miscellaneous—Clerk of Works, Quantity Surveyor, printing and advertising, legal expenses, etc... ..	252	6	1
Total	£5,700	0	0

DISCUSSION.

Mr. G. W. Lacey: I have very great pleasure in proposing a vote of thanks to Mr. Smith for his paper. With regard to the evaporation, I should like to ask whether the allowance is taken at four-fifths of the rainfall or determined by any particular observations made during the time the rainfall was being gauged? One thing which must strike one is the enormous cost of obtaining a Bill in Parliament—3290*l.* seems a lot of money for the Council to have to spend in order to fulfil the duties imposed on them by the Public Health Act. Clause 34, making provision for the inspection of services, is certainly new and is different in its terms from what we have in the Oswestry Act, though I do not know that it covers any more ground. Our clause says that "the service-pipe connected with the mains shall be laid under the superintendence of the corporation." That seems to give powers for inspection, because you cannot very well have supervision without inspection. Certainly the Kettering clause is a useful one, as it lays down in specific terms that every part of the service-pipe, as well as all the fittings, shall be inspected by the local authority. I notice in the description of the culvert that provision is made in the centre for plugging up at any time if it is thought desirable. I should like to ask what particular reason there is for doing that. I notice that the height of the embankment above the overflow level is not mentioned. With regard to the drainage, I see that a drain is laid for the village of Loddington, situated a mile above the new reservoir embankment and discharging into the waste-water channel. Is that intended to convey sewage or only surface water? If the former, it does not seem desirable to have it so close to the reservoir. With regard to the filters, Mr. Smith has not provided ventilators, as is usually the case. His filters have been at work, and probably he will say whether they have worked as he expected. I should like to know if Mr. Smith has discovered any cause for the subsidence of the embankment which was not discernible by boreholes in the strata. Perhaps there is a looser and softer part above the clay, which may have had something to do with it. The piling has apparently checked the movement, but he does not say whether he has any fear with regard to the distortion of the clay-puddle when the reservoir is

filled with water. The prices given at the end of the paper are very useful.

Mr. J. P. NORRINGTON: I have pleasure in seconding the vote of thanks proposed by Mr. Lacey. Anyone who has been connected with towns must be very sensible of the enormous waste of water which goes on entirely through the poor class of fittings used. Take the house fittings: you get pipes which leak in about seven years' time; you get taps which leak in about twelve months after you start using them. These are a constant source of annoyance. Then there is the larger question of pipes in the streets. A great number of street openings are caused by defects in these pipes.

Mr. W. R. LOCKE: I should like to ask Mr. Smith if he can give us any figures as to the working expenditure and income of the undertaking. In a similar case of a Water Act we have a clause which provides that only the repayment of principal can be made a charge on the general district rate; and any deficiency on the interest account on the working of the undertaking we have to raise by means of a deficiency rate on the consumers only. That was a clause put in by the Parliamentary Committee. Therefore you will understand that when this rate had to be raised on the first year's working it did not increase the popularity of the undertaking for the time being. Owing to the expense of the purchase of the undertaking, and the cost of obtaining the Act, which amounted to 4500*l.*, we have had to provide a very large sum indeed to make up this amount.

Mr. H. G. COALES: I should like to know whether the 28 gallons of water per day consumed per head includes water for flushing, cleansing of markets, and trade purposes, or is it only a domestic supply? Why is it that so large a proportion of the population were not supplied by the waterworks? Did they have a water as good in the wells? I should be glad if we could have an analysis of the water supply. In the neighbouring town of Rothwell the water is so charged with iron that it petrifies anything it comes into contact with, and they have to soften it. The Kettering water comes from the same strata; the Northampton sand over the lias clay. Therefore it would be very interesting to know what the analysis of your water is. I was interested in hearing that you had been looking round the Naseby district, because so has Market Harborough. That is a very high table-land 560 ft. above sea-level, and if you could

get water from that district you would have a gravitation scheme. According to the paper the main was tested when laid up to 300 feet. Did you have any breakages or defective pipes, or did they all stand?

Mr. W. O. Thorp: With reference to the cost of obtaining the Act, I may say that in Malvern we are going in for a water scheme, on which we are spending 22,000*l.* to 23,000*l.*, and we had to lay out 4600*l.* in getting Parliamentary powers. Our Act was practically an unopposed one. When there is so much talk about municipal extravagance I think it is time that Parliament took steps to lessen the burden of obtaining powers. With a mixture of clay and ironstone in the geological formation, I should be curious to know what kind of water you obtain below that. The by-law as to the plumbers' fittings seems to be a very good one. As to leakage from fittings, we are not troubled with that difficulty. Every house is supplied by meter, and as a consequence the consumption is only 12 gallons per head per day. With reference to the filters, I notice that you propose adopting a head of 2 ft. I do not know what experiments have been made here, but at Malvern I have been taking analyses of water from a head of 9, 12, 18 and 24 in., and I find that our analysis comes out better with 12 in. head on the filters. I should like to know if any examination has been made of the puddle wall, both in the portions which have slipped and the portion which stood firm.

Mr. W. Harpur: I should like to say a word as to the cost of obtaining an Act for the carrying out of new public works. It is no doubt a crying shame that the cost of obtaining powers for constructing necessary sanitary works is so very high. I was concerned in a Bill which passed Parliament two or three years ago—a sewerage Bill—and I saw a report the other day that the cost was within a few pounds of 20,000*l.* That is a Bill which was opposed in both Houses. Still, to add 20,000*l.* on to the cost of the works is an abominable shame, to say the least. One other point in which I feel interested, and which has not been referred to in the discussion, is the power to frame by-laws for preventing the pollution of the watershed area from which a water supply is drawn. That I think is a most important point in any water scheme where you have a catchment area, and where pollution is possible by the inhabitants of that area. I think you have done very wisely in obtaining powers to make

at least secure the purity of your watershed area. Many districts have suffered very seriously in consequence of pollution of the area. In a recent one in the district of Mountain Ash, and earlier in the Rhondda Valley, near my own district, there have been serious outbreaks due to the pollution of the watershed areas. Therefore I say you have been extremely wise and fortunate in obtaining special powers whereby you can control the purity of the area from which your water supply is obtained.

Mr. T. READER SMITH, in reply, said: I am very much obliged to you for your vote of thanks for the paper. It has been a great pleasure to me to prepare it, and to arrange the meeting here, though I confess it takes up a good deal of time. The first question was as to the evaporation. We made no special experiments to ascertain this. Mr. Hawksley has done a good deal of work in this direction, and has pretty well established the fact that the evaporation in this part of the country amounts to 16 in., so we adopted that figure. As to Clause 34, the point with us was rather this: we had ample powers to supervise the laying of pipes, but no power to compel anyone to send us notice. No plumber can now cover up a service pipe any more than a builder can lay a drain without our knowledge. He has to send us a notice before he covers it. With regard to the stopping of the culvert, I had no particular reason for supposing it would be necessary, but in constructing I thought I would make the provision in case of any unforeseen accident. With an open culvert, every point is under inspection and every valve. The height of the top of the embankment above the overflow is 5 ft. As to the Loddington drainage, the drain takes the place of the stream, and whatever water the people of Loddington were previously entitled to put in the stream, they will now put in the drain. There were attempts to make us responsible for the purification of the whole of the water that may come from the drain, but we have a clause providing that nothing we do shall relieve the parish of Loddington of its responsibility. As to the ventilation of the filters, no ventilators have been carried through the sand. They are a great nuisance, and in designing the new filters I decided to do without them. The new beds work very well, and give no trouble, so we are quite satisfied. As to the subsidence, perhaps I have omitted to say that the valley is rather a steep-sided one, and there is a flat piece where the stream runs which is alluvial. We saw what it was in taking down our puddle trench, which was 20 ft.

deep. It looked good enough to carry the weight that was to be put upon it, and that is proved by the down face of the embankment which has not given. I cannot say more about it than this—that the natural drainage having been cut off it became waterlogged, and proved unequal to carrying the weight. We did not see anything that would lead us to suppose that anything of the kind would happen. The expense we are now being put to is pretty much the same as if we had had to form heavy concrete walls in the ground at the start, except that some material has to be twice moved. Apart from that I do not think there is any additional expense on the work which would not have been incurred if we had supposed at the start that the ground was not satisfactory, and we had had to make the foundation good. We are now going to put a shaft down in order to prove the embankment. We shall start at the lowest point of the subsidence and sink down to the original ground level below, so that we shall be able to see what has happened to the puddle wall, and make a section of it. With reference to expenditure and the repayment of capital under our Act, the cost of obtaining the Act has to be repaid within five years, and the other capital expenditure is to be spread over a period of sixty years. We make good the deficiency of income to meet expenditure from the general district rate, so that all, whether consumers or not, have to pay this alike. That is an advantage, because when anything goes wrong with a well the owner says, "I may as well have the town water as I shall have to pay something for the water in any case." The wisest course seems to be to make everybody pay, as they can all benefit by what is provided for public purposes. To meet loan charges we provided a reserve fund, so that we are averaging for what would have been at the start a very heavy repayment. The consumption of water given per day includes the use of the commodity for all kinds of trade purposes. The Midland Railway Company take 700,000 gallons a week, and our trade consumption works out at an average of about 9½ gallons per head per day. We are not fully metered, but we are to a very large extent. Then as regards analysis, our well water is very hard, about 28° of hardness. Our reservoir water is also rather hard, about 13°. We register the plumbers. I am glad to say we did not crack any pipes in testing up to 300 ft. I should have tested up to 600 ft., but when you have a long length of main it takes a long time to pump it up. The rate for labour here is *5d.* per

hour. As to borings on the site, we put a few boreholes down. We know the ground very well. The foundation of this part of the country is the blue lias clay. There has been no lateral movement of the middle wall. It has come forward a little on the top side, but it is not a very serious matter. We were proving some of the cracks the other day, and we found they had disappeared altogether 3 or 4 ft. down, and the worst crack was entirely out at a depth of 6 ft. Our supply from wells is not great. At present we are pumping from both of them. Shortly we propose to dispose of one of them to a neighbouring authority which is short of water. They are seeking powers to acquire it, and we are obtaining powers to dispose of it. As to the head on the filters, we have not made experiments. The average head is about 2 ft. When we bought the works it was 2 ft., and it has served us very well.

COMMUNICATED REPLY.

The Council's first Act, 1898, giving compulsory powers for purchasing the undertaking, cost 1911*l.*, and the 1901 Act, empowering them to construct the works, cost 3291*l.*, making the total Parliamentary expenses 5202*l.*

The character of the water-supply from our Cransley reservoir varies during the year, being influenced as to its mineral constituents by the rainfall, but the following analyses during 1905 by Mr. E. W. Voelcker, the county analyst, are fairly representative.

—	Grains per Gallon.			
	February.	April.	July.	October.
Total solid residue	19·32	20·72	13·44	17·64
Oxygen absorbed	0·067	0·069	0·072	0·076
Lime	6·41	7·50	3·92	5·12
Magnesia	0·93	0·81	0·86	1·01
Sulphuric acid	2·73	3·11	2·56	2·72
Nitrogen as nitrates	0·06	0·108	..	..
equal to nitric acid	0·23	0·417	..	..
Chlorine	1·05	1·08	1·10	1·18
equal to chloride of sodium	1·75	1·77	1·81	1·94
Free ammonia	0·0075*	trace	none	0·001
Albuminoid ammonia	0·007	0·007	0·005	0·008

* This is a very unusual quantity; there is rarely more than a trace.

The Author has no recent analyses of the well water which forms a small portion of the town's supply: the latest appear to have been made by Dr. Dupre in 1887; they are as follow:—

—	Samples from Wells at	
	Weekley.	Clover Hill.
Appearance	Clear	Clear
Colour	Very pale greenish	Very pale greenish
Smell	Inodorous	Inodorous
Deposit	Very minute trace	Very minute trace
Nitrous acid	None	Ditto
Phosphoric acid	Trace	Strong trace
Poisonous metals	None	None
Hardness before boiling	28° Clark	22° Clark
Hardness after boiling	4° Clark	4·5° Clark
	Grains per Gallon.	
Oxygen absorbed	0·014	0·013
Total dry residue	30·45	33·95
Colour of residue	White	White
Behaviour of residue on ignition ..	Does not darken on heating.	Does not darken on heating.
Chlorine	0·95	1·19
Nitric acid	0·35	0·39
Ammonia	0·0007	none
Albuminoid ammonia..	0·0015	0·0007
Main mineral constituents of residue	..	..
Carbonate of lime ($CaCO_3$)	23·91	25·48
Sulphate of lime ($CaSO_4$)	3·54	4·18
Sulphate of Magnesia ($MgSO_4$) ..	0·33	0·33
Silica (SiO_2)	0·45	0·45
Chloride of sodium (NaCl)	1·53	1·96

With further reference to the subsidence; when the upper part of the embankment, which had been badly fissured adjoining the puddle-wall, had been removed sufficiently to obtain a sound foundation for its reconstruction, a shaft was sunk through the embankment to the ground surface below, to ascertain, if possible, the nature of the movement, and also if the puddle wall

was still intact or had been damaged. This showed that the movement of the ground had carried forward a portion of the embankment for about the length of the subsidence, forming a fissure in the embankment, which, starting at about 20 ft. from the puddle-wall, at ground level, cut into it about 20 ft. above ground level; that the plastic puddle had squeezed into this fissure under its own weight, totally filling it, and that the puddle wall above had travelled forward with the embankment a distance of about 3 ft.

A trench cut across the puddle wall at the central point of the subsidence, where this movement had been greatest, proved the face of the puddle wall to be in its right position on the down stream side, 4 ft. below the level to which it had been taken down. A trench was therefore excavated to this depth along this side for the length of the movement, and the puddle wall made good and carried up in its proper line.

THE KETTERING COMBINED ELECTRICITY WORKS AND REFUSE DESTRUCTOR.

By F. J. BAKEWELL, Assoc. M. Inst. E.E.

The Kettering Urban District Council obtained the provisional order authorising the construction of their electricity works in 1896, but owing to the pressure of other undertakings the order was not proceeded with until its revocation was threatened by the Board of Trade. The Council then called in Messrs. Kennedy and Jenkin, who prepared the plans and estimates and advised them throughout as far as the electricity works are concerned, whilst the buildings and refuse destructor were designed and supervised by the Council's surveyor, Mr. T. Reader Smith.

Several possible sites in different parts of the town were considered, before the present site off the Rockingham Road was finally decided on as being the most central and convenient for the combined electricity and refuse destructor works.

At the Local Government Board inquiry there was a good deal of opposition to the scheme proposed, owing to the fears of the residents that the destructor would cause a nuisance from smoke and smells, but the whole scheme was finally approved, and sanction obtained to a loan of 43,275*l.* for the electricity works and mains, and 5100*l.* for the refuse destructor. The fears of a nuisance have fortunately been proved to be unfounded, and there has not been one complaint since the opening of the works on May 7, 1904.

The site covers $1\frac{3}{4}$ acres of ground, with a main entrance in Rockingham Road; and another entrance, for the carts to the destructor, from Upper Field Street Avenue. On the east side of the buildings ample space has been left for the erection of public baths, which the Council propose building in the future.

The buildings are of brick, of a very good design, being well set off by a very handsome chimney. They are very well lighted by a lofty roof, consisting of glass and slate, with match-boarding

under the slates; a special feature being the zinc louvres, which are so shaped that they very effectually exclude rain and spray, even in the worst storms, whilst allowing free passage to the air. The whole of the buildings and plant have been so designed and laid down, that extensions can be added without interference in any way with the existing plant, and at minimum cost.

The battery room, which is situated next the offices, contains 240 cells of the Electrical Power Storage Company's make, of a capacity of 450 ampere-hours, at a discharge rate of 150 amperes, divided into two batteries. These batteries, arranged one on each side of the 3-wire system, are always worked as complete units, there being no regulating cells whatever, the regulating being accomplished by means of two reversible boosters. These machines, which are situated in the engine room, run at 850 revolutions per minute. The motors are connected across the outer bus bars of the switchboard, whilst the generators are designed to give 90 volts in either direction when carrying a current of 133 amperes. The shunt regulating resistance of the generator is especially interesting, being designed to be fixed to the front of the switchboard platform, and to take up as small a space as possible. The rheostats consist of a fixed resistance of 500 ohms connected across one side of the 3-wire system, this resistance being divided into equal portions from which connections are taken to a series of contacts on the slate switch panel fixed to the top of the frame, to which the terminals of the shunt winding are connected by means of a sliding switch. These contacts are so arranged that when the switch is in the middle position, both the field terminals are connected to the centre of the resistance, so that there is no potential difference between the terminals and no current passes though the field windings; consequently the machine is not excited. As the switch is moved towards either end, the connections to the field are gradually moved away from the centre of the resistance, one in either direction, so that when the switch reaches the end of the slide there is a maximum potential difference between the terminals of the field winding, and the machine is fully excited. The contacts are arranged in duplicate and cross connected, so that, by moving the switch to one side or the other from the middle position, the machine is excited in reverse directions. This method of regulation has been found to be simpler and more satisfactory in working than the normal method of cell regula-

tion, besides doing away with the usual complicated and costly network of leads to the battery. One of these machines has a small milking dynamo coupled to it, capable of generating 133 amperes at from 2 to 10 volts, for milking up any particular cells.

The engine room at present contains four Williams and Robinson 2-crank engines. The two larger ones, of 250 I.H.P., are coupled direct to two 155 K.W. 6-pole shunt-wound Parker dynamos; whilst the two smaller ones, of 125 I.H.P., are each coupled to two 37½ K.W. 6-pole shunt-wound Parker dynamos in tandem. The two machines of each of these smaller sets are connected on to either side of the 3-wire system and act as steam balancers. The armatures of these 37½ K.W. machines are all provided with a coupling at both ends, and are all interchangeable, so that should any one of them break down it can easily be replaced by the one spare armature or by any of the others.

An 8-ton travelling crane, built by Messrs Carrick and Ritchie, has been provided for overhauling, etc.; it is supported on rails on each side, running the whole length of the engine room.

The main switchboard, which is mounted on a raised platform on the side of the engine room, remote from the boiler house, was supplied by Messrs. Cox-Walker of Darlington. The whole of the connections at the back of the board and the leads from all the generators and boosters, and to the batteries, consist of base copper run on porcelain insulators on an iron framework, in order to prevent any risk of fire; this is especially interesting, as this was the first station where this method was completely carried out. The leads from the generators and boosters are run in a subway under the engine room, and are arranged very simply and systematically, the positive and negative leads being kept distinct throughout in two separate groups. All the fuses and meters in the machine and battery circuits are arranged on the wall behind the board, each set being, as nearly as possible, behind the panel connected to its corresponding machine. The board is of a very simple design, being divided up into fifteen panels of enamelled slate carried by an iron frame. On the left are six panels for the six dynamos, on the right two feeder panels for four feeders and one middle wire panel, and in the middle are the two battery panels with two panels for the

booster generators and booster motors on each side. The dynamo panels are each fitted with an ammeter, two maximum and reverse current circuit breakers, plug bars, a voltmeter plug and double change-over links which enable the machines to be run with self-excitation or to be separately excited from the battery by means of auxiliary excitation bus bars. The booster motor panels are each fitted with a starter, a centre-zero ammeter, two plug bars, a voltmeter plug, and a D.P. switch; the booster generator panels, with two maximum current circuit breakers, a centre-zero ammeter, two plug bars, a shunt-break switch and voltmeter plug; the battery panels, with a maximum current circuit breaker, disconnecting switch, centre-zero ammeter, one plug bar, a bus bar coupling switch and voltmeter plug. The middle wire panel is fitted with three centre-zero ammeters for the middle wire, earth connection and milking dynamo, a D.P. switch and field switch for the milking dynamo, a voltmeter plug and two feeder pilot voltmeter switches. The feeder panels carry four main switches shunted by small fuses and four ammeters. There are no fuses in circuit with the feeders, the small fuses being connected in parallel with the switches, to enable their being opened under a heavy load without burning the contacts. The main bus bars are run in duplicate the whole length at the back of the board, and are arranged so that any machine can be coupled up to either of them; they can also be coupled up directly in parallel by means of the bus bar coupling switches on the battery panels. The feeders are connected to either set of bus-bars by means of flexible connections. The plugs and connections to the boosters are so arranged that each machine can be used for charging or discharging either battery or to booster up or down either of the main pairs of bus bars. Above the board twelve voltmeters are erected in pairs on swivel brackets, so that they can be seen from any desired position in the engine room. The shunt regulating rheostats for the main dynamos and boosters are erected along the front of the switchboard platform, each opposite the panel corresponding to its particular machine and in easy reach of the attendant. The middle wire is earthed, as required by the Board of Trade, through a recording ammeter in circuit with an automatic cut-out, which falls out on the earth current exceeding 20 amperes and puts a resistance in circuit, ringing a bell and lighting a lamp at the same time; the whole of

this apparatus is erected on the wall at the back of the middle wire panel, and so that the lamp is in sight of the attendant.

The boiler house at present contains three Lancashire boilers, 28 feet by 8 feet diameter, fitted with cross circulating tubes of the Galloway type, and designed for a working pressure of 160 lb. per square inch, the plates being $\frac{13}{16}$ inch thick. The boilers have been so designed that automatic stokers can be readily fitted in the future, but at present they are fed by hand, the coal being tipped into bunkers directly in front of them. The feed water, which is obtained from the town mains, is supplied to the boilers by two 4-inch Weir feed pumps, each capable of delivering 3500 gallons of water per hour from an overhead storage tank, 14 feet by 8 feet by 8 feet, through a 4-inch Kennedy meter and Green's economiser, by means of a duplicate system of feed pipes. Each boiler is fitted with the usual fittings. The main steam branches are connected to a complete ring main, with branches to the engines in the engine house. This main is very efficiently drained by two large separators and several steam traps. The steam of the pumps can be taken either from an auxiliary steam main connected direct to each boiler, or else from a duplicate main connected to one of the separators. The exhaust pipes from the engines are connected, in a subway under the engine room floor, to a 20-inch diam. main exhaust pipe, which is connected to a silencing chamber in a conduit outside, and from thence is continued to the top of the chimney, being suitably stayed the whole way up. Provision has been made for connections to a feed water heater being fitted in the future, and also for a connection to the baths to supply them with exhaust steam for heating purposes when erected. All the drains from the steam and exhaust pipes, and the exhaust from the pumps, are emptied into two large sumps outside the buildings next the economiser. The destructor house contains a two-cell simplex Meldrum's destructor, guaranteed to be capable of destroying seventeen tons of refuse in sixteen hours, which is fed by hand, the refuse being tipped from the floor above in an open hopper in front of the destructor. The hot gases, after passing through the combustion chamber, are taken to the chimney either directly through the flues of a 28 feet by 8 feet Lancashire boiler or through a by-pass flue. The flues are also arranged so that the gases can be passed through the economiser together with the gases from the coal boilers, or taken

direct to the chimney. The furnaces are fitted with steam blowers, the air to which is heated by being drawn through a regenerator, consisting of a battery of tubes, through which the waste gases pass after leaving the boiler. The boiler is designed for a working pressure of 200 lb. per square inch, being made of $\frac{1}{8}$-inch plates, and, with the exception of the furnace grates, is otherwise made exactly similar in all respects to the coal boilers in the station boiler house. The water is fed into the boiler by a separate 2-inch Weir pump, capable of delivering 1000 gallons of water per hour through a 2-inch Kennedy meter. The feed pipes to the boiler are duplicated, so that the boiler can also be fed direct from one of the station pumps when necessary. The steam to the blowers is taken either from a connection on the destructor boiler, or else from one of the auxiliary steam pipes from the station boilers, which permits of the steam blast being used for the destruction of refuse when the boiler is shut down for cleaning or repairs. The steam from the destructor boiler passes to the main steam ring in the station boiler house, through a reducing valve and non-return valve, which reduces the pressure to the normal working pressure of the station, namely 160 lb. per square inch. This permits of a variation of 40 lb. pressure in the destructor boiler, which is found to be very necessary in working the plant owing to the great variations in the temperature of the destructor gases, due to the varying qualities of the refuse and to the time taken for clinkering, etc.

The whole of the cables in the town consist of Glover's lead-covered paper insulated cable, laid solid in wood troughs filled up with pure Trinidad bitumen and covered with blue bricks. The network is divided into four districts, connected together by detachable fuses, each district being fed by a 0·3 concentric feeder with a 3-core pilot volt lead from the bus bars of the feeding box to the station, which enables the volts of any feeding point to be readily ascertained at the station. The town is at present lighted by 30 Gilbert arc lamps, arranged to burn 10 in series. These lamps are of the double-carbon type, and are capable of burning sixty hours without re-carboning, which considerably reduces the cost of attendance. Two 32-candle power incandescent glow lamps are erected on each post for the all-night lighting, the switches for which are erected in the end posts of the arc series together with the arc lamp switches, bu

having independent control. The Council have recently decided to considerably extend the electric street lighting throughout the town, and have placed a tender with Messrs. Johnson and Phillips for the erection, under the supervision of Messrs. Kennedy and Jenkin, of over one hundred ½-ampere A-type Nernst lamps, giving 80-candle power each, in those parts of the town wherever the electric light distributing cables are laid, this type of lamp having been found by experiment to be the most satisfactory for lighting the by-streets.

The undertaking has so far proved very successful, in spite of the great depression in trade and the very keen competition which has been met with from the gas company. This success is partly due to the low charges for energy, namely 4½*d.* per unit for lighting, and 2*d.* and 1½*d.* per unit for power, and partly to the Council's scheme of wiring consumers' premises and supplying motors for a small rental or on hire purchase; the charges being 6 per cent. and 8 per cent. per annum for the wiring of houses and the supply of motors respectively, and 12½ per cent. per annum for either on a ten years' hire purchase, these percentages being reckoned on the actual cost of the installations to the Council.

One of the chief advantages of this system of assisted wiring is, that the Council's engineer can insist on the installations being wired to his own specifications, and thereby obtain a much better class of work throughout the town than he would otherwise have power to enforce. It also enables him to advise the consumers as to the best and most economical forms of lighting. As a comparison between the relative cost of electric light and gas, very satisfactory testimonials have been received from numerous consumers, pointing out that their bills for electric energy, both for lighting and power, have either come out less or very slightly more than their previous corresponding gas bills, although they have a much better light with its numerous advantages.

The working costs of the station have been very satisfactorily brought down during the ten months ending March 31, 1905, having been reduced from 4·5*d.* per unit sold in June 1904 to 1·54*d.* per unit sold in March 1905, averaging 1·76*d.* per unit sold for the whole ten months. Although the combination of the destructor with the electricity works is a decided saving to the Council as a whole, the working costs are not in any way

reduced as far as the electricity works are concerned, but are, if anything, slightly increased, as the whole of the steam used from the destructor boiler is paid for to the public health department; and an extra amount of coal is used owing to one of the station boilers having to be always kept banked in case of the failure of steam from the destructor, although this extra cost is as far as possible taken into account in estimating the coal equivalent of the destructor. In order to obtain this coal equivalent very careful readings have been taken each month of the evaporation and coal consumption per unit generated of the station boilers, the amount of coal used per hour for banking, etc., and the evaporation per unit generated of the destructor boiler, whenever either have been used separately. From these results average figures have been obtained for the number of pounds of coal used per unit generated by the station boilers, after eliminating the coal used for banking and for the initial raising of the boilers to working pressure, and the number of pounds of water evaporated per unit generated by the destructor boiler. From the results obtained, 9·5 lb. of coal per unit generated, and 71·2 lb. of water evaporated per unit generated by the destructor boiler, have been decided on; so that, by dividing the total water evaporated by the destructor boiler during each month by 71·2, the number of units generated by destructor steam only are obtained, and on multiplying this amount by 9·5 the nearest coal equivalent of the destructor steam for the month is obtained.

The total amount of coal saved by the use of destructor steam during the ten months ending March 31, 1905, works out by the above method to 389 tons, at 11*s.* 10*d.* per ton including cartage; which is equal to 230*l.*, payable by the electricity department to the public health department, from which an amount reckoned at 50*l.* per annum is deducted for management and wages of men employed by the electricity works for attendance to the pumps, boiler cleaning, and other incidental work done on the destructor, etc.

The results obtained by the destructor itself have been very satisfactory, about 14 or 15 tons being destroyed per day by one shift of three men working ten hours per day in the summer months, and about 20 to 22 tons being destroyed in the winter months by two shifts of two men working eight hours per shift. In order to obtain these results, the destructor has to be shut down for two and a half days once in every four weeks in

summer, and once in two weeks in winter, for cleaning out the combustion chamber and flues. An interesting result of the high temperatures normally obtained in the combustion chamber is, that the fine dust deposited there is solidified into a very hard mass, which has to be broken out with wedges and sledge hammers.

The capabilities of the destructor are shown by the following results obtained at the official test of the plant after six months working. Duration of test = $10\frac{1}{2}$ hours.

Total weight of refuse destroyed .. 18 tons 17 cwt. 0 qr. 21 lb.	= 42,245 lb.
" " tins, pots, etc.	343 lb. = 0·80 per cent.
" " clinker .. .. 4 tons 15 cwt. =	10,640 lb. = 25·18 per cent.
Normal allowance flue dust	8·00 per cent.
Total weight of total incombustible residue ..	33·18 per cent.
" " refuse destroyed per hour after deducting tins, pots, etc... ..	4023·33 lb.
" " refuse destroyed per hour per square foot of grate area	80·46 lb.
Actual weight evaporated	52,290 lb.
" " per hour	4980 lb.
" " per lb. of refuse	1·24 lb.
" " from and at 212° F. ..	1·48 lb.
Calculated percentage of steam used for blowers	14·7 per cent.
Average steam pressure	180·67.
" temperature of combustion chamber ..	1989° F.
" " of boiler downtake	1167·6° F.
" " after regenerator..	690·6° F.
" " at chimney base	245·5° F.
" " hot-air conduit	328·5° F.
" gas analysis	11·69 per cent. CO_2. 8·60 per cent. O. 0·23 per cent. CO.

In conclusion, it is very satisfactory to notice that the usual dirt and unpleasantness of the destructor, which is one of the chief objections of electrical station engineers to a combined works, have been very efficiently kept out of the engine room and station boiler house by the general arrangement of the works, and by having the whole of the destructor department thoroughly swept and washed down every day.

Public Lighting.—The charges made by the electrical department for street lighting are 17*l.* per annum for each of the 30 arc lamps, including the two 32 candle-power incandescent lamps on each arc lamp standard, and 3*l.* 3*s.* per annum for all the ½-ampere Nernst lamps, except those which are left alight all night, for which a charge of 5*l.* 5*s.* is made. These charges

include all current, labour, cleaning and repairs, and also repayment of loan and depreciation. The arc lamps and most of the Nernst lamps are alight from sunset till 11 p.m. The incandescents on the arc posts and a few Nernst lamps at important places from 11 p.m. until 1 hour before sunrise.

DISCUSSION.

Mr. G. W. LACEY: I notice for the engine bed it was necessary to go down 6 ft. deeper than for the foundation of the walls. It has occurred to me whether there will be any vibration of the ground under the foundation of the building.

The tests of the destructor have come out very well. What use has been made of the clinker from the destructor? I should also like to be informed of the cost per cube ft. of the power station.

Mr. W. O. THORP: I notice there is a payment of 230*l.* by the electricity department for the saving of coal effected by the use of the destructor. It seems rather unusual for the electricity department to pay anything for refuse. My experience has been that electrical engineers seem to have a very marked objection to taking refuse at all.

Mr. W. HARPUR: I think the District Council acted very wisely in undertaking the work, whether a profit or a loss may result, because the loss to the ratepayers will not be greater than if it had been left to a company.

Mr. H. RICHARDSON: I should like to ask the distance apart of the arc lamps for street lighting; also if Mr. Smith can tell us whether the system of free wiring has been a success; and whether there has been any trouble experienced through consumers leaving houses that have been wired by the Council, and the incoming tenants not taking the light. I suppose there is a contract with the consumer; and I should like to know if there is any definite period or amount for which the consumer makes himself responsible. In connection with the chimney of the electric lighting station, referred to in Mr. Smith's paper, I notice that the shaft is lined for half its height with fire-brick, set in clay, the bottom portion in the square base being 9 in. thick and the octagonal part above, 4½ in. thick. I had a diffi-

culty with an old octagonal stack where the lining was only 4½ in. thick. The binding at the angle was very imperfect, and on examination it appeared that each was a separate wall detached from the other. The consequence was that the top layer of bricks became loose. I took the lining off for a distance of 50 ft. and then covered the cavity with concrete slabs. This prevented any loose bricks falling behind, and prevented any dust or anything else collecting at the back of the lining. I don't know whether our case is peculiar, but it is certain that the stack was badly constructed. It appears to me that all the eight quoins of the stack are parting from the wall faces, and there is a long jagged crack on each side of the angle the whole length of the stack. I do not know how that has been occasioned, but the result is we have had to put bands on the whole length of the stack.

Mr. T. Reader Smith, in reply, said: As to our engine bed, it was taken down to this depth to make it uniform all over. We have no vibration, or at least nothing that one can discover, unless one stands on the engine bed itself. We have been able to use all the clinker ourselves: we have been making footpaths on our main roads, and we shall also be able to use it at our sewage disposal works. The cost of the concrete foundation was 15*s.* per cubic yard. The street lighting I cannot say very much about as to charges, because it is not in my department. The distance between the arc lamps is 70 yards, and the other lamps are about the same distance apart as the gas lamps were originally. Then as regards free wiring. That is rather out of my hands. I had something to do with it at first; but, of course, not now. I may say that at present we have a three-sided agreement. A person who wishes to wire his house will select his own tradesman, who will do the work. It is usual to get an estimate from two or three, and when he has made his selection he will apply to the Council to wire his house. If the Council are satisfied they will instruct the tradesman selected to do the work, pay his bill when it is done, and charge a percentage to cover the cost of the work in a short term of years. The agreement has to be signed by the Council, the tenant and the landlord, and it reserves the whole of the wiring and fixtures as the property of the Council until they are paid for. We have not had very much trouble with houses fitted in this way becoming vacant, and the wiring left on the Council's hands. We had a Bill in Parliament last year,

and they granted us all we asked for as regards raising loans for this purpose, the supply of meters and other things of that sort, the amount authorised being 20,000*l*. With reference to the saving in coal, I may say that we think what is left after making the deductions stated is a fair saving. There are a number of authorities who are doing this. One we visited at Darwen, and the payment there is something like 300*l*. per annum. There is also the point which Mr. Harpur has mentioned as to companies. The Council and the committee who investigated these matters came to the conclusion that if a company came in we should have to pay a very large sum for their services, and the plant they would select for the work would not be such as we should select ourselves. That is probably what influenced the Council in their decision to undertake the work for themselves.

On the proposition of Mr. W. Harpur, seconded by Mr. J. P. Norrington, a hearty vote of thanks was accorded to the Chairman and Members of the District Council for the use of the room for the meeting.

The Members had luncheon together at the Royal Hotel, Mr. W. Harpur, acting President, in the chair.

The afternoon was devoted to visits of inspection of the electric light station and destructor, the new reservoir works at Thorpe Malsor, and the Cransley Waterworks.

HOME COUNTIES DISTRICT MEETING AT TOTTENHAM.

October 21, 1905.

Held in the Council Chamber of the New Town Hall, Tottenham.

A. E. COLLINS, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Chairman of the District Council (Mr. W. E. Warran) received the Members and offered them a very hearty welcome to Tottenham.

The President, on behalf of the Association, thanked the Chairman for the kind welcome that had been offered them.

Mr. R. J. Thomas was unanimously re-elected Hon. Secretary for the Home Counties District.

THE LOCAL ADMINISTRATION OF TOTTENHAM AND ITS DEVELOPMENT.

BY W. H. PRESCOTT, A. M. INST. C. E., M.I.M.E.,
Engineer and Surveyor.

IN endeavouring to present information on the civic life and progress of Tottenham in as condensed a form as possible, the difficulty has been to abridge it to the degree one would have desired without doing injustice to the importance of the several municipal works, which have recently been carried out by the Council, under the Author's direction, for the prosperity and well-being of its citizens.

The works referred to represent an actual expenditure of over

half a million of money, which have been required to make provision for a rapidly increasing population, and which, it is hoped, will exercise an important influence on the welfare of the district.

GENERAL STATISTICS.

Tottenham in the ancient record of Domesday Book is called Toteham. It formed part of the hundred of Edmonton, in the County of Middlesex, and is situated in latitude 51° 35′ 59″ N., and in longitude 0° 4′ 31″ W. from Greenwich, and is about 6 miles from Charing Cross. It is bounded on the east by Walthamstow in Essex, from which it is separated by the river Lea, on the west by Hornsey and Wood Green, on the north by Edmonton, and on the south by Hackney and Stoke Newington.

The form of the parish is irregularly trapezoidal.

The etymology of the name is derived from two Saxon words, "Toten" and "Ham"; the former word signifies a projection with a long end or corner like a horn, and is supposed in this instance to have originated from the form of the western part of the parish (now Wood Green); "Ham," the latter portion of the word, is a common termination to the names of places, and signifies a town or dwelling place. According to some authorities the ancient Roman basilical way led through part of Enfield Chase in its passage to Hertford, which road, coming from Moorgate and passing through Newington, and thence through several "green lanes" to the east of Hornsey, entered Enfield Chase. This was the road by which the Londoners marched on, with King Alfred at their head, in the year 895, to attack a strong fortification the Danes had built at Hertford.

From Pole's "History of Middlesex" we find that about A.D. 1210 the headlands, commons, waste grounds and greens, formed a very considerable part of the county of Middlesex. They were granted to the tenants of the respective manors for pasturage for their cattle, for fuel and other necessities; some of them were very extensive and belonged to and made parts of this parish, viz.: Wood Green, West Green, Duckett's Green, Hanger Green, Beans Green, Bounds Green, Chapman's Green, Else's Green, Page Green, Tottenham (High Cross) Green, etc.

The area of the district is 3033 acres, divided into six wards. The population at the 1901 census was 102,531, and is now estimated at about 125,000.

The rateable value of the district is 483,360*l*. The general district rate for the half-year ending with the September quarter is 2*s*. 2*d*. in the £, and the poor rate for the same period is 2*s*. 2*d*. in the £.

On March 31, 1905, the total amount of the Council's loans outstanding was 404,910*l*. Of this sum 41,705*l*. is allocated to the Council's water department (which has been transferred to, and is now controlled by, the Metropolitan Water Board), and will shortly be paid off, and 23,288*l*. to the Urban District Council of Wood Green, which district prior to the Separation Act of 1887, formed part of Tottenham.

The number of houses is 21,254.

From the report of the medical officer of health for the year terminating December 1904, the mortality rate was 11·5 per 1000, including 0·764 per 1000 for the seven principal zymotic diseases (probably the lowest zymotic death-rate in the kingdom).

Public Roads.

At the end of March 1905, the total length of roads and streets within the district was 60½ miles, of which nearly 4½ miles are main roads and 4⅛ miles contributory roads. The whole of the main roads are paved with wood on a 6-inch foundation of Portland cement concrete; Jarrah blocks being used for the portion between the tramway metals and creosoted deal for the breasts of the road. This work was performed concurrently with the laying of the tramway track, when it was being remodelled to suit the requirements of electric traction, two years ago. A loan of 37,900*l*. was raised for the work, 9450*l*. repayable in twenty years (concrete), and 28,450*l*. (wood blocks) in five years. The Middlesex County Council are reimbursing the Council the interest and instalments of the loan. The total cost per square yard works out at 13*s*. 9*d*.

For the purposes of scavenging and maintenance the district is divided into three sections, each under the control of a separate foreman, and all repairs are executed by direct labour. Although a number of the old gravel roads still remain, the greater number are macadam. The material used for repairing the surface of all roads—other than those paved with wood or granite setts—is Leicester and Guernsey granite, broken to pass through a 1¾-inch

ring, and rolled in with granite chippings, for which purpose three steam rollers (two 10-ton and one 12-ton) are kept almost constantly at work. Each of the rollers is fitted with a Morrison's scarifier, which do their work satisfactorily and appear to add very slightly to the cost of repairs.

The cost of maintenance of the main roads is borne by the county authority, who also contribute a moiety towards the upkeep of the subsidised roads, one of which was partially paved with "red gum blocks" nearly five years ago at a cost of 4123*l.*; the cost per square yard in this case worked out at the rate of 15*s.* 8*d.*, and the road is now in a most satisfactory condition, considering the time the wood has been laid. The loan for this work was granted for a period of ten years.

The average cost of scavenging and maintenance of ordinary highways and main roads for the year ended March 1905, works out at about 243*l.* per mile.

The prices of the granite macadam for the current year, delivered direct on to the roads, are as follows:—

	s.	d.	
1¾-inch Leicester granite	11	3	per ton.
" " chippings	10	0	"
1¾-inch Guernsey granite	13	11	"
" " chippings	10	11	"

The following list gives the rates of pay to the various classes of roadmen:—

	Rate per week. £	s.	d.
District foremen	2	15	0
Roller drivers..	2	2	6
Carmen	1	9	0
Scavengers	1	7	0
Roller lads	0	15	0
Orderly boys	0	12	0

The Council pays an amount of 6*d.* per load for a shoot for surplus earth, road sweepings, slop, etc.

The footways in the public streets are paved with various materials, of which York stone flags, artificial stone flags, and asphalt are the principal kinds; tar paving is used in several places where the traffic is but light. Street crossings are formed of granite setts grouted in cement and laid on a bed of 6 inches of cement concrete.

STREET LIGHTING.

The public streets at the present time are lighted solely by incandescent gas supplied by the Tottenham and Edmonton Gas Light and Coke Company at 2*s.* 10*d.* per 1000 cubic feet. The company's charge for supplying and erecting new lamp columns fitted with single incandescent "C" burner is 3*l.* 7*s.* 6*d.* each.

The following list gives the number of lamps in use up to the June quarter, and the price for lighting, cleaning, and extinguishing:—

No. of Lamps.	Consumption of Gas per hour.	Class of Incandescent Burner.	Annual Cost of Lighting, Cleaning, and Extinguishing. £ s. d.
1719	3½	Single "C"	2 16 6
4	7	Double "C"	4 18 0
229	4½	Single "No. 4 Kern"	3 10 0
14	9	Double "	6 5 0
18	20	Lucas Light of 700 candle power	12 0 0
4	12	" " 400 "	7 0 0
1988			

In addition to the above there are two sewer gas destructor lamps, the gas to which is metered; the charge for maintenance is 15*s.* per lamp per annum.

For the single light burners an annual charge of 2*s.* 8*d.* per lamp is made for maintenance, and for the double burners 5*s.* 3*d.* per lamp.

It is proposed, as soon as the electric cables are laid by the North Metropolitan Electric Power Supply Co., to light the main thoroughfares by arc lights suspended from the centre poles along the tramways.

PRIVATE STREETS.

The statutory powers for the making up of private roads within the district are contained in the Tottenham Local Board Act, 1890; the provisions of which are, with a few exceptions, very similar to those contained in the Private Street Works Act, 1892. Under the Council's Act no power is given to the raising

of a loan for such works, but, instead, facilities are placed in the Council's hands for the recovery of the money on the provisional apportionment. Interest at the rate of 5 per cent. per annum also can be charged from the date of the final apportionment in lieu of 4 per cent. as provided in the 1892 Act.

Tenders are invited for the making up of all private streets, and the lowest is usually accepted.

The general construction is as follows: 9 inches hardcore, 2 inches gravel, 4 inches Leicester granite, rolled in with granite chippings; footways are paved with artificial stone flags on 4-inch hardcore; granite kerb 12 inches by 8 inches laid flat; channelling formed of three rows of granite setts; crossings formed of granite setts; kerbs, channels, and crossings are laid on 6 inches of 6 to 1 cement concrete. The cost per foot run of frontage works out at about 15*s.*; and the amount spent in private street improvements is about 25,000*l.* per annum.

Prior to the appointment of the Author as engineer to the Council, the surface of all highways, other than main roads, was finished with a coating of Hertfordshire gravel; his observations of this material in bulk and under the action of traffic convinced him that it was a material which left much to be desired, and he accordingly recommended the use of granite for forming the finished surface of the roads, with a consequent improvement in their condition.

Sewers and Special Drainage.

The duplicate system of sewers is employed in the district, and the Council has over 250 miles of public sewers under its control. In 1896 a "Special Drainage Committee" was formed, which had for its object the examination and tracing of all sewers vested in the Council, in order to ascertain their exact positions, depths, and condition. When the examination of a sewer is completed the position and levels are plotted on a large scale ordnance map, and reported on in a special book. These form a valuable record of all sewers to which the staff of the Council constantly refer for information. For this work the whole district is divided into six areas; as soon as the whole of the sewers in one area are traced, plans and sections of the faulty sewers are prepared, and application made to the Local Government Board for a loan to defray the expenses of any

improvements which may be deemed necessary. In connection with this very important work four areas have already been examined and the faulty sewers in them rectified, and put in thorough working order at a cost of 16,899*l.*, and the examination of the fifth and sixth areas is now in progress.

The length of the sewers actually traced and examined since 1896 is 66 miles of soil sewers and 45 miles of surface water sewers, or a total of 111 miles.

Main Sewerage and Pumping Station.

At one time the adjoining district of Wood Green formed part of the parish of Tottenham, but in 1887 an Act was passed which formed Wood Green—whose area was approximately a quarter of the whole district—into a separate municipality. Under this Act a separate Board, known as the "Tottenham and Wood Green Joint Drainage Board," and formed by representatives from both districts, was constituted to deal with all matters appertaining to sewers which were the common property of both parishes, and to the disposal of the whole of the sewage from the joint area.

A new outfall sewer, 5 feet by 3 feet 4 inches, has lately been constructed at a cost of 30,000*l.*, which was necessitated principally through the development of the London County Council Housing Estate, which alone is estimated to contribute over one million gallons of sewage per day of 24 hours.

The sewage is forced from the pumping station through 21-inch and 30-inch cast-iron rising mains into the London County Council system situated in the Metropolitan Borough of Hackney, whence it eventually arrives at the Northern Outfall Works at Barking. The engines and their capacities at the sewage outfall works are briefly as follows:—

1. One 45 h.p. horizontal single cylinder condensing engine, date 1873, driving by a continuation of its piston rod, one double acting pump, 2 feet diameter and 4 feet stroke. Capacity at 16 revolutions per minute, 3½ million gallons per 24 hours.

2. One 100 h.p. compound condensing beam engine, date 1886, driving from the beam two plunger pumps, each 2 feet 2 inches diameter and 4 feet 3 inches stroke. Capacity at 16 revolutions per minute, 4 million gallons per 24 hours.

3. Three triple expansion horizontal Worthington sets, date

1905, driving by a continuation of the piston rods, double acting plunger pumps, 2 feet 3 inches diameter and 1 foot 3 inches stroke. As each set is in duplicate there are in all 6 pumps and 18 steam cylinders. They have been designed to work at 100 lb. per square inch steam pressure at the rate of 38 double strokes per minute; the three sets are capable of pumping 20,000,000 gallons in the 24 hours.

The engines are supplied with steam from three Lancashire boilers; the two old ones are 30 feet by 7 feet with a working pressure of 70 lb. per square inch, and the new one is 21 feet by 7 feet, working at 100 lb. per square inch.

The feed water heater provides for the heating of the feed water prior to its entry into the boilers.

The cost of the three Worthington sets, new 30-inch delivery main, chimney shaft, and alterations to existing buildings, was 13,800*l.*

The Author is the consulting engineer to the Joint Drainage Board, and carried out these sewerage operations in conjunction with the engineer to the Joint Drainage Committee (Colonel P. E. Murphy, M.Inst.C.E., V.D.).

Building Department.

It may interest some Members to learn that one of the powers enjoyed by the Tottenham Council under its special Act of Parliament is the authority to charge building fees to pay the salaries of the building inspectors.

Five building inspectors are employed in this department (under the control of the engineer and surveyor), each of whom receives a salary of 200*l.* per annum. It is further prescribed that no person is eligible for appointment unless he holds the statutory qualifications granted by the Royal Institute of British Architects to act as a district surveyor in London, or as a "building surveyor" under local authorities granted by the same, or is a Member, or Associate Member of the Institute of Civil Engineers, or a Fellow, or a Professional Associate of the Surveyors' Institution. The inducements offered have not always proved sufficiently attractive to secure satisfactory candidates to fill vacancies, and the Council some time since, acting under the Author's advice, made application to the Local Government Board to exercise their powers of enlarging the list of qualifications by including the testamur granted by the "Associa-

tion of Municipal and County Engineers," First Class Honours in Building Construction, South Kensington, and some others: but the application was, for some unknown reason, declined.

The fees received from builders more than cover the salaries of the five inspectors. Some Members of the Association have recently suggested the sweeping away of existing by-laws, and substituting a universal Building Act; it surely must have been forgotten that such an Act would probably repeal the private Acts that most large local authorities have expended a considerable amount of money and labour to obtain, and very many valuable clauses would thus be lost altogether; the power to charge building fees, for instance, which some few authorities possess, but which the blue pencil of the Local Government Board invariably strikes out of new Acts of Parliament, would probably be one of them. Whilst such an Act would give the advantage of uniformity, the Author submits it would be at the expense of the loss of elasticity; moreover, the task of getting such an Act through Parliament is not to be lightly thought of, while the still greater difficulty of getting obnoxious clauses amended after would be almost insuperable. In the Author's judgment the experience of the London County Council with their two still-born building Acts shows how futile any attempt to pass a universal building Act would be.

The following definition of a "new building" contained in the Tottenham Act, which is most useful, may interest some Members:—

Section 43. (1) The erection of any building. The re-erection wholly or partially on the same site of any building of which an outer wall is pulled down or burnt down to or within 10 feet of the surface of the adjoining ground of any frame building so far pulled down or burnt down as to leave only the framework of the ground floor storey thereof;

The conversion into a dwelling house of any building not originally constructed for human habitation, or the conversion into more than one dwelling house of a building originally constructed as one dwelling house only;

The reconversion into a dwelling house of any building which has been discontinued as and appropriated for any purpose other than that of a dwelling house;

The conversion of a dwelling house into any other building not intended for human habitation;

The making of any addition to an existing building by raising any part thereof, or making any projection therefrom, but so far as regards such addition only; and

The roofing or covering over an open space between walls or buildings;

Shall for all purposes of this Act, and the Public Health Acts, and the Act of 1890, and any by-laws made thereunder respectively, be deemed to be the erection of "a new building," and the word "building" shall for all such purposes include an erection or building of a permanent character of whatever material constructed.

(2) Section 76 of the Act of 1890 is hereby repealed.

Refuse Collection and Disposal.

For many years prior to the introduction of the present method of dealing with the refuse of the district, the collection and disposal was in the hands of contractors, who, under the terms of their contract, were required to find a shoot without the parish boundaries.

Owing to the unsatisfactory manner in which the work was done, the Council, at the end of the year 1902, decided to dispense with the services of the contractor and undertake the whole business of collection and disposal themselves, and application was made to the Local Government Board for sanction to borrow an amount of 27,300*l.* to cover the cost of the horses, harness, vans, and destructor works. Sanction to the raising of the loan was received in February 1903.

Some thirty horses and a similar number of patent covered tip vans were purchased, and advertisements issued inviting the submission of schemes for refuse destructor furnace plants, to which a number of firms responded. Before ultimately making a selection a committee was appointed to visit and inspect the plants at various towns and districts similar to Tottenham, the issue of which was to select the scheme of Messrs. Goddard, Massey and Warner, of Nottingham, at a contract figure of 8,259*l.* 4*s.*

Tenders were at the same time obtained for the appurtenant buildings, i.e. destructor house, inclined approach, chimney shaft, manager's cottage, weigh office, boundary walls, etc., and that of Messrs. H. Knight and Son, of Tottenham, was accepted, at the amount of 13,681*l.*

The destructor plant consists of a single row of ten cells, of the usual back feed type, with grate and drying hearth at an inclination of 1 in 5, each with a grate area of 40 square feet, 6 feet 8 inches long, by 6 feet wide. The forced draught is produced by means of fans, a separate one being provided for each furnace.

Each cell is situated between a by-pass flue and a boiler; the gases from a pair of cells can thus be passed through openings in the side walls of the furnace at the front of the grate into the by-pass, or may be diverted through the boilers, when steam is required to be generated. A mono-rail conveyor along the front of the cells removes the clinker to the crusher

Five multitubular boilers are provided, each slung between a pair of cells, and formed of two drums; the lower drum contains the tubes and is filled with water, and the upper one contains steam and water. Each boiler is fitted with both dead weight and double lever safety valves, and if necessary, can be coal-fired from an independent grate.

The main flue, 6 feet high by 3 feet 6 inches wide, is situated immediately under the drying hearth, and runs the full length of the destructor, enlarging beyond the last cell into the combustion chamber, into which cattle, condemned meat, fish, infected mattresses, etc., are placed for destruction.

The dust arrester adjoining the combustion chamber is formed of a series of baffle walls, which facilitate the precipitation of the light dust. At this point the flue divides into two parts, one portion giving direct access to the shaft, and the other forming a space into which is built a Green's economiser of 160 tubes.

Outside the building, at the east end of the site, a clinker crusher, elevator, and screen, with three grades, is fixed, driven from a line of counter shafting.

The power for driving the fans and crusher is furnished by a horizontal single cylinder steam engine, cylinder 12 inches diameter, stroke 24 inches.

The water for feed purposes is taken from the town mains, passed through a Lassen and Hjort softener, and then forced through a Worthington positive meter and also a feed water heater into the boilers.

The chimney shaft is octagonal in plan, 170 feet high above

the ground level, lined with fire-brick to a height of 100 feet, and with a diameter of 8 feet 4 inches. The foundations are taken a depth of 20 feet 6 inches below ground, into the London clay, and the shaft rests upon a solid block of Portland cement concrete, 10 feet thick, and 36 feet square. The shaft imposes upon the clay foundation an intensity of pressure of two tons per square foot, and was built from inside.

The internal dimensions of the destructor house are 122 feet by 50 feet by 28 feet high to the eaves from the clinkering floor, built in stock brickwork, with a plinth of blue Staffordshires; the roof is slated, and has a louvred ventilator its full length. The tipping platform is 122 feet long, 26 feet 6 inches wide, and 16 feet above the floor of the engine and fan room formed under this platform, and is paved with 4-inch granite cubes.

The inclined approach road is 325 feet long, with a clear width of 18 feet and a gradient of 1 in 20; the lower portion is formed by filling in between two retaining walls, and the upper is constructed of piers and arches. The surface of the road is finished similarly to the tipping platform, and the side walls are finished with a stone coping and iron railing. The spaces under the arches have been formed into a two-stall stable, mess room, lavatory, conveniences, and workshop.

The yard immediately adjoining the buildings is paved with granite setts purchased from the Metropolitan Electric Tramways Company when the lines were converted from horse to electric traction.

The works were officially opened on June 23, 1904, and have been in constant operation ever since.

One complaint as to smoke was received when the destructor was started; but this was more fanciful than real. The weight of refuse destroyed during the twelve months ending June 30, 1905, was 21,757 tons, of which some 655 tons was fish offal; the greatest quantity of refuse destroyed in one day was 102 tons, and the makers' guarantee is 37 lb. per square foot of firegrate per hour, which gives 160 tons per day of twenty-four hours as the capacity of the plant. They also guarantee an evaporation of $\frac{3}{4}$ lb. of water per lb. of refuse. The cost of burning works out at 1*s.* 7·1*d.* per ton, exclusive of interest and repayment of capital. Up to the present there has been a

ready sale for the clinker, old tins, etc. The following is the list of charges:—

	s.	d.	
Clinker	1	0	per load of 25 cwt.
Fine ash	1	0	per ton.
Crushed clinker	2	0	„
Old tins	17	6	„
Old iron	1	0	„

The asset for the first year's working was 360*l.*

In the summer the main flues are thoroughly cleaned out every 10 to 11 weeks, and in winter every 8 weeks; it has, however, been found advisable to free the by-pass flues between the cells every week to insure proper combustion. The work of cleaning the main flues is done on Sunday, when the plant is shut down, so that no interruption of the working occurs.

When the provision of a destructor first came up for discussion, it was considered jointly with a municipal scheme for lighting the district with electricity, generated from a station proposed to be erected on the destructor site, using the waste heat from the destructor plant for supplying a portion of the electrical machinery. The chimney shaft and destructor generally were designed and erected with this object in view; a change of Council has, however, resulted in the municipal electricity scheme being definitely abandoned.

The cost under the "contract system" amounted to 6400*l.* per annum, the cost under the new system is 7600*l.*, included in which is an amount of 2330*l.* 15*s.* per annum for interest and repayment of loans; if, in addition, allowance is made for the value of the steam generated, it will be seen that there is a considerable saving under the new method.

In selecting the destructor site the Council were governed by certain cardinal principles, the main one being the haulage of refuse after collection; the site fixed upon is so convenient that refuse can be carted to the approach road by several different ways, commanding as it does the main arteries of Tottenham. Although there is a slightly increased cost with the new system, the advantages to the general health of the community are unassailable, and beyond the reach of any adverse argument.

When the Council had under discussion the merits and demerits of the various destructor schemes submitted for their consideration, special attention was given to the method of charging the cells; one of the clauses in the Author's original

specification laid special stress on the provision that the refuse was to be tipped direct from the vans into the hoppers without handling or storage of any kind, and the scheme which best dealt with this and other particular points was the one eventually selected as conforming most nearly to the terms of the specification.

The Author is unable to give particulars of any official test, as up to the time of writing the plant is in the hands of the contractors, who have been unable to carry out a test owing to the illness of the leading partner in the firm.

Electric Lighting.

The Council obtained a Provisional Order in July 1902, and various schemes were prepared; but none were adopted by the Council.

After a chequered history the Council have now decided, subject to the approval of the Board of Trade, to conclude an agreement with the North Metropolitan Electric Power Supply Company, who are covenanting to supply the district with electrical energy before October 1, 1906.

Small-Pox Hospital.

The district was visited with an epidemic of small-pox in 1901–2, which cost the ratepayers of Tottenham over 12,000*l.*, and a temporary hospital was erected within the space of three weeks by the Council on land adjoining the destructor site to cope with the outbreak. The sum of 6000*l.* was expended on buildings and tents, and over 600 cases of small-pox were treated at this hospital, a large proportion thereof being of a very malignant type.

The actual cost per head for treating the patients at the Council's hospital was less than 7*l.*, as compared with over 11*l.* per head which had to be paid by the Council for 88 patients sent to South Mimms from the district.

The present Medical Officer of Health (Dr. J. F. Butler-Hogan, M.D., LL.B., Barrister-at-Law) took office when we were in the throes of this epidemic, and never probably in the history of Tottenham was there a time when those to whom was entrusted the care of the public health and the adminis-

tration of sanitary legislation occupied a position of greater difficulty and responsibility.

The buildings were constructed of galvanised iron and timber on brick foundations, and were destroyed by fire on the cessation of the epidemic.

Council Offices, Baths, Central Fire Station, Etc.

Competitive designs were invited for these buildings in September 1902, and a scheme was ultimately accepted by the Council; the works were commenced on May 16, 1904, and completed in October 1905; the whole of the fittings for the offices were made in the Council's workshops, and the furniture of the council chamber, committee rooms, retiring rooms, etc., was supplied and fixed by a London firm. The total cost of the scheme, including the acquisition of the site, is expected to reach 70,000*l*.

Depots, Stabling, and Workshops.

It was the strongly felt need for a general depot in which the work of the district could be centralised, and the stores and material carefully guarded and distributed, that led to the acquisition of certain land in the rear of the Council buildings. Its situation is practically the topographical centre of Tottenham, and as it adjoins the railway, and is in close proximity to the main road arteries—north, south, east, and west—it is admirably fitted to be a great arterial centre of Council work and activity, and is of the greatest assistance in the endeavour to conduct the work of the district efficiently and economically.

The site is about 2½ acres in extent, approximately square, and the buildings are arranged on all four sides, and the area not built upon is paved with granite setts on a concrete foundation, and is utilised as a store yard and railway siding. Entrance is gained to the depot yard from Clyde Road by a short length of granite-pitched roadway.

Facing the entrance are situated the clerks' and weighbridge offices, fitted with a 10-ton Avery's weighbridge, and storerooms for all kinds of material; provision for the storage of cement and timber is made in another block of buildings. Stabling is provided for 54 horses in six 9-stall stables, with three loose boxes, and accommodation for the Author's horse and trap in

addition; fodder and harness rooms are arranged in connection with each stable; three houses are situated in the yard for the accommodation of the district foreman, storekeeper, and assistant horsekeeper. The workshops are placed in blocks of buildings on the eastern boundary, and consist of smiths' shop with four forges, and wheelwrights' shop on the ground floor, carpenters' and painters' shops on the first floor; the harness makers' shop and store is situated in the other block on the same boundary. Steam-roller house for two rollers, cart sheds, mess rooms, and lavatory are also provided on the same site.

This depot was occupied in November 1903. The Council, through their works department, carry out all their own jobbing repairs, and in addition have done work which was formerly let out to contract. The depot has been modelled upon a general comprehensive plan, and the total cost of the works (inclusive of the siding and paving of the yard) was 18,578*l*., and although they have been in operation but a short space of time, it has already been proved that the concentration of this work in one centre tends to the more expeditious and economical performance of these important duties.

Conway Road Depot.—This depot and store yard is situated in the Harringay ward at the rear of the Harringay Motor Fire Station. The accommodation provided on the site is as follows: 8-stall stable, with loft, 1 loose box, a workshop, storeroom, pay office, cart sheds, steam-roller house for 2 rollers, house for assistant horsekeeper, and conveniences for the men.

The whole area of the yard is paved with granite setts, and the right of way forming the entrance from Conway Road is paved with Jarrah wood paving.

These buildings were erected in 1903; the cost of the depot and fire-station was 5884*l*., and the loan was granted for a period of 30 years.

Bruce Castle Depot.—This depot, consisting of a 12-stall stable with harness and fodder rooms and a store yard, serves the needs of the southern portion of the district; it is a relic of bygone times, and quite inadequate for modern requirements. It is contemplated to pull down the existing buildings in the near future, and to erect cart-sheds, stabling, etc., more suitable for the purpose. Plans have already been prepared by the Author, but they have not yet been presented to the Council for their approval.

Housing of the Working Classes.

In 1900 the Council acquired an estate of 14 acres for 8600*l.*, and the Author was directed to prepare a scheme for the erection of workmen's dwellings. The scheme was duly approved, and application was made to the Local Government Board for sanction to a further loan of 102,000*l.* to carry out the work. An inquiry was held on May 12, 1902, at which there was tremendous opposition by builders and others; since this inquiry took place, the London County Council have deposited plans for the development of a huge estate in Tottenham for housing an estimated population of 42,500 at an estimated cost of 1½ millions; the work is now in hand.

In view of this, the Council decided in July of this year not to proceed further with the scheme prepared by the Author, and the application for permission to borrow the sum of 102,000*l.* for that purpose has accordingly been withdrawn.

The legal committee has now been instructed to consider and report as to the advisability of leasing the land for building purposes to a suitable tenant or tenants, the Council reserving to itself the right to stipulate as to the building of houses and their construction generally.

Parks and Open Spaces.

Parks and open spaces have always been a subject of deep interest to the Tottenham Council, and it may not be generally known that the open spaces in this district have an area of over 240 acres, which can never be covered by buildings, and are open to the enjoyment of the public for ever.

There can be no doubt that the preservation of the open spaces, and the formation of parks in large towns is of the highest importance; old and young alike feel the refreshing effect of breathing a pure air, surrounded by trees and flowers, and it is a matter for congratulation that the Tottenham Council have always kept this steadily before them and done their duty in their day and generation in providing adequate open spaces which are a credit to the district.

Bruce Castle Park.—This park has an area of 20 acres, and was purchased in 1892 at a cost of 15,000*l.*; it is connected with the name of Scotland's hero, King Robert the Bruce. The park

is a beautifully wooded place, possessing smooth lawns in deep shade, tennis courts, bowling greens, and an old and picturesque mansion with a quaint central tower known as Bruce Castle. On the site of this present mansion was built the original Bruce Castle, a mediæval fortress, by the crusading Bruce after his return from the Holy Land, whose eldest son became King Robert the Bruce.

The mediæval fortress in time gave place to a Tudor mansion, and a curious old circular tower, locally called the "Donjon," may now be seen in front of the present house; this is a relic of the Tudor house, visited by Margaret, Queen of Scots, and Queen Elizabeth, who stayed there for two days with the Compton family, whose arms can now be seen on the garden front of the present mansion.

Towards the end of the seventeenth century, the mansion gave place in its turn to the house now standing.

In 1827 the estate was put up to auction and bought by a family of schoolmasters of the name of Hill, who had views on education very far in advance of their times, and who made Bruce Castle School a great success. One of these masters became known throughout the world as Sir Rowland Hill, the introducer of the Penny Post, the birthplace of which was Bruce Castle.

Downhills Park and Recreation Ground.—The land for this park and recreation ground was acquired in 1902, and was laid out by the Author in the same year, and opened in August 1903.

The area of the park and recreation ground is 30 acres.

Financial Particulars.

	£
Amount borrowed for purchase of land	18,150
Amount borrowed for laying out, fencing, etc.	8,790
Middlesex County Council's Contribution	6,050
Amount borrowed for kerbing, paving, channelling, etc. ..	2,950
	£35,940

It will be seen from the above figures that the park is not very large in extent, but it will vie in loveliness and beauty with any park in the metropolitan area. Visitors are delighted with the charm of its wooded recesses, the avenue of hornbeams, (believed to be the most perfect extant), the Italian gardens and

parterres, ornamental ponds and fountains, rockeries, tennis courts, bowling greens, and palm houses, which are all to be found within the acreage of Tottenham's newest "lung."

Chestnuts Park and Recreation Ground.—The land for the above was purchased in May 1898, and has an area of 13 acres; it was laid out by the Author principally as a recreation ground, with cricket and football pitches, bowling greens, etc., against a background of ornamental shrub and flower beds. The old mansion on the estate has been converted into a library and public reading rooms.

Lammas Lands and Commons.—The Council are the owners of 117¼ acres of land lying in the far east of Tottenham, locally known as the "Lammas Lands." An Act of Parliament was obtained in 1900 to acquire power over and extinguish the Lammas rights over these lands, which are now the absolute property of the public; football and cricket pitches are allotted by the Council to applicants, this being greatly appreciated. The Council also approached Parliament and claimed power to have all "commonable" lands under their control, which are now closed at night and kept in proper condition; the powers thus sought and obtained have enabled the Council to convert them into beautiful open spaces, greatly adding to the advantage and attractiveness of the district.

The Council retain a staff of 28 hands as gardeners, commons and park keepers, etc.; they also levy a charge for the use of the tennis courts and bowling greens, which has produced in the four summer months an amount of 65*l.*

Council's Water Undertaking.

The Author, up to June 1904, also acted as "water engineer," over two-thirds of the district being supplied with water by the Council.

The following is a brief outline of the works:—

Hale Water Works.—Built in 1852 and 1857, supply is obtained from the underlying chalk by means of sunk and bored wells.

The water is raised into a tank near the surface, which forms a suction well, from which the water is pumped either into service reservoirs, or a tower tank at the Downhills.

There are two wells: the first was sunk in 1851–2, and is

8 feet in diameter for the upper 71 feet, and is continued by an 18-inch bore to a further depth of 329 feet.

The second well is 12 inches in diameter, bored its whole depth to 250 feet from the surface.

The engine-house is placed alongside the well first-mentioned. There are two beam-engines: No. 1 of the compound surface condensing type of 45 h.p., cylinders 28 inches and 15 inches diameter respectively and 5 feet stroke, working a high lift ram and bucket pump for raising the water to service reservoirs or tower tank as necessary. This engine also actuates the well-pump by a line of countershaft, and is interchangeable in this duty with No. 2 engine. No. 2 engine is a single cylinder low-pressure jet condensing engine of about 27 h.p., working a high lift ram and bucket-pump, and performs the same duties and acts as a stand-by to No. 1. The well-pump is a single-acting pump, and works at a depth of 250 feet, has a bucket 14 inches in diameter, stroke 36 inches, works at 20 revolutions per minute, and delivers 540,000 gallons per 24 hours into the suction-well. There are two pumps in the engine-room, a horizontal duplex pump and a quadruple-acting vertical pump for raising the water from the suction-well into the tower tank. Steam is generated by two Lancashire boilers 7 feet 6 inches in diameter and 28 feet long.

Park Pumping Station.—Erected in 1893. There are two wells at this station, one in the yard, and the other under the centre of the floor of the engine-room. The latter is 12 feet in diameter at the top, and 8 feet at the bottom; depth 198 feet, continued with a bore-hole 25 inches in diameter to a further depth of 254 feet. The well pierces the chalk to a depth of 48 feet, and has one heading 6 feet by 4 feet 6 inches, driven a distance of 240 feet. The first mentioned well, which originally was sunk to a depth of 150 feet, was, in 1902, deepened another 100 feet, and connected to No. 2 well by a heading. Three headings, varying in length from 86 feet to 112 feet, were driven from the extra sunk portion of No. 1 well. The engines are in duplicate, of the compound horizontal type, with surface condensers, working at about 50 h.p. The high pressure cylinders are 16 inches in diameter, low pressure cylinders 26 inches, stroke 36 inches. The well-pumps are in duplicate, single-acting, of the ram and bucket type, and actuated by spur gearing from the engines; buckets 22½ inches

in diameter, plunger 16 inches in diameter, stroke 4 feet. Each pump delivers about 648,000 gallons per 24 hours into the reservoirs. There are two Lancashire boilers 7 feet in diameter by 30 feet long, with 6 Galloway tubes in each furnace. A residence is provided for the driver in charge.

Reservoirs, Tower Tank, etc.—These are situated in the highest part of the district, and comprise: Two underground service reservoirs, constructed in brickwork, with arched roofs on piers and properly ventilated; united capacity, 1,000,000 gallons. One water tower and tank 34 feet by 34 feet by 12 feet, with a capacity of 60,000 gallons for supplying the higher portion of the district; the floor of tank is 60 feet above ground level.

The total length of water mains within the Council's area of supply was 50½ miles.

When the London Water Bill of 1902 was introduced by the Government the Council was at once confronted with a most serious and important matter; a very thorny problem which required their careful thought and serious consideration; the question before them was whether they should ask the Government to include Tottenham in the area of supply proposed to be established under the Water Board, or continue to keep the water undertaking under municipal control and management. It was sought by the Government in their Bill to transfer to the District Council so much of the plant and business of those companies as were in Tottenham, and the Council would have been required to refund to the Water Board the ascertained value of such plant and business; whilst we were able to secure sufficient water to supply our present area the idea of being compelled to take over the supply of the whole district was looked upon with considerable disfavour, and it was ultimately agreed by a unanimous vote that the passing of the proposed Bill would be highly detrimental to this district, and strong reasons were adduced for bringing Tottenham within the limits of the Act without in any way depreciating the value of the Council's undertaking; the valuation of the undertaking was prepared by the Author, and in the end the sum of 77,700*l.* was paid to the Council by the Metropolitan Water Board for the plant and works, which they took over in June of last year.

This left a balance of over 30,000*l.* after paying off all out-

standing loans, and the final agreement was considered by the Council to be eminently satisfactory. If this Bill had not been opposed Tottenham would have been isolated and surrounded by one powerful water company whose business it would have probably been to study the welfare of the neighbouring districts at the expense and to the detriment of the Council, whilst Tottenham would have been wholly dependent upon the Water Board for any supplementary supply needed for its inhabitants unless further wells were sunk (a method of supply comparatively expensive and uncertain in its results), and thus the injustice from which Tottenham has suffered in being deprived by the companies of its natural supply from the River Lea would have been aggravated. The Author would like to take this opportunity of saying how much the public of Tottenham are indebted to their representative on the Metropolitan Water Board (Mr. Councillor P. B. Malone, J.P.), who worked so indefatigably and successfully during the conducting of the negotiations.

Open Air Swimming Bath.

This bath is situated on the Tottenham Marshes, close to the Stonebridge lock on the Lea Navigation, and is built above ground as the river on the upper side of the lock is formed in embankment.

The measurements of the pond are: length 180 feet, width 60 feet, depth 3 feet 6 inches at shallow end to 6 feet at deep end.

The walls are constructed in concrete composed of one part Portland cement to six parts Thames ballast, and in some places are carried down 7 feet below ground level, owing to the presence of loose made-up earth and running sand. The bath is made watertight by a rendering of Limmer asphalt on the interior face of the work ½ inch thick on the walls, and ¾ inch thick on the floor, placed on in two layers.

Dressing boxes and open dressing sheds are provided round three sides of the bath, and also foot-bath, urinal, and earth closets.

Under agreement with the Lea Conservancy Board the water is taken from the reach above the lock and returned below it; a charge of 1*d*. per 1000 gallons is made by them for the use of the water.

The work of construction was put in hand at the beginning of last winter, mainly with a view to relieve the distress of the unemployed of the district, and the whole of the labour was derived from this source.

The total cost was 4000*l.*, of which 2033*l.* was spent in wages. The Author considers the employment of casual unskilled labour on this class of work most unsatisfactory, and estimates that the wages bill was increased in consequence to the extent of about 70 per cent.

The bath was completed and opened at the beginning of last June, and has proved very popular; the largest number of bathers in one day was 1769. The charge for admission is 1*d.* per head, and an extra charge of 1*d.* is levied for costume and towel.

On the first 12 weeks' working an amount of 209*l.* was received.

It is proposed to keep the bath open only during the summer months: one day per week is set apart exclusively for ladies.

The bath is filled with fresh water twice every week, and is thoroughly scoured and cleansed prior to every filling with clean water.

Tramways and Light Railways.

There are 4½ miles (double track) of tramways in the district, and 1½ miles (double track) of light railways. Previous to the electrification of the tramways, about 18 months since, the district was served by the old-fashioned system of horse trams along the main roads. The electric tramways along these thoroughfares now belong to, and are run by, the Metropolitan Electric Tramways Company, to whom also are leased the lines of light railways in Bruce Grove and Lordship Lane, constructed and owned by the Middlesex County Council under their Light Railways Order of 1903; the service is good and frequent, and renders the adjoining country, together with the City and West End of London, very easy of access.

When the company promoted their Bill for the electrification of the system, the Author recommended the Council to raise no opposition to the company obtaining additional powers on their agreeing to remove the granite setts from the then existing tracks and substituting in their place approved wood blocks on

a concrete foundation at the entire cost of the company, together with certain street widenings to be effectuated by them at certain points at an estimated cost of 76,000*l*.

Where the carriageway exceeds 32 feet in width, permission was given to fix centre poles to carry the overhead equipment, and in cases of less width than this, side poles were used.

The Light Railways above referred to are connected with the large system of tramways being carried out by the county; under the provisions of their Light Railways Order the Middlesex County Council were required to form new footways, and acquire all necessary lands and properties to widen the light railway routes to 50 feet throughout, in addition to providing and laying all surface water sewers necessary for the drainage of the roadway and the adjoining estates; the track is double throughout, and paved with creosoted deal blocks on a cement concrete foundation.

Side poles carry the overhead equipment.

Fire Stations.

The erection of a central fire station, with firemen's dwellings, has just been completed. The buildings find accommodation for the fire superintendent, six married men, and eight single men. A large engine room, watch room, recreation room, stables, and workshops are also provided.

The following apparatus, with four horses, are stationed at these headquarters:—

1 steamer.

1 combined chemical fire engine, hose tender, fire escape, and motor.

The latter machine has been built, at a cost of 900*l*., in the Council's own workshops, under the supervision and direction of Supt. Eddington, of Tottenham, who first originated the idea of combining a hose tender, chemical fire engine, fire escape, and motor in one car, and Mr. Eddington is to be warmly congratulated on the production of a most efficient apparatus. It has been designed for the special purpose of combining all the very latest and most scientific improvements intended to save life or extinguish fire.

The motor is a 30 h.p. Simms, driven by the Simms-Bosch magneto ignition, with secondary battery ignition in case of

the other failing, fitted with patent speed gear; the wheels are twin pattern, built specially for this engine. The motor carries two 35-gallon chemical engines, 600 feet of hose, one 50-feet fire escape, two lengths of Pompier ladder, and case containing medical aid appliances. The maximum speed is 26 miles per hour.

The central fire station does not mark the era of the fire brigade in Tottenham, but is an extension of the Council's brigade, owing to the enormously increased population of the district.

In 1903 a "motor fire station" was erected from the Author's designs by the Council for the Harringay district of Tottenham at a cost of 3550*l.* This, it is believed, was the first motor fire station to be erected in the world, and is equipped solely with motor appliances.

In addition to a combined chemical fire engine, hose tender, fire escape and motor, there is provided an oil fuel motor steam fire engine, which is one of the "Gem" pattern steam fire engines built by Messrs. Merryweather and Sons.

It is fired by means of vaporised oil, and is capable of pumping 320 gallons per minute; powerful brakes and excellent stearing gear are fitted, and any speed up to 30 miles per hour can be obtained. On arrival at a fire the driving machinery is easily thrown out of gear, and the pumps put on. The engine carries two cylinders, containing 36 gallons of oil, or sufficient to last for seven or eight hours at an ordinary fire.

The cost of the combined chemical fire engine, etc., was 750*l.*; the motor steam fire engine cost 750*l.* The Council have several other fire stations in the district, and keep (besides the superintendent) 24 firemen, whose wages range from 30*s.* to 50*s.* per week. The brigade was taken over by the Council about twelve years ago, prior to which it was purely and simply a "volunteer" fire brigade on the most primitive basis. It is now acknowledged by the representatives of the two greatest cities of the empire, who, with many others, have honoured the district with special visits to view the "fire appliances," that the Tottenham Fire Brigade is amongst the best equipped, and one of the most efficient in the kingdom.

The brigade also laid down and maintain some fifty fire alarms, and the Council's private telephone service.

Education.

Provided and Non-Provided Schools.—There are 10 provided schools and 11 non-provided schools in the district, which accommodate some 22,000 children.

The Council delegated all their powers under the Education Act 1902 to an education committee, except the power of raising a rate or borrowing money and the purchase of sites for the erection of new schools.

The Author was appointed "surveyor" to the education committee after the passing of the Act, and has the oversight of all buildings coming under the jurisdiction of that committee.

Conclusion.

No review of the administration of the district would be complete without some brief reference to the excellent and useful work carried out in the Public Health Department under the able direction and control of the Author's friend and colleague, Dr. J. F. Butler-Hogan, LL.B., Barrister-at-Law, the medical officer of health.

The good effect of the great sanitary works and efforts of this department is vividly shown by the steady and maintained diminution of the death-rate.

The Author's acknowledgments are also due to the esteemed and able clerk of the Council (Mr. E. Crowne), who has acted as clerk for 35 years, for the generous support accorded him during a time of exceedingly great activity, and also to the loyal and energetic staff comprising the engineer's department, who have shown a proper appreciation of their duties and laboriously sought to promote the welfare and best interests of the district.

The Author cannot conclude without offering his warmest thanks to the several gentlemen who are members of his Council for the unwearied kindness and active assistance he has received from them in the performance of his duties during the whole course of his official connection with this ever-increasing community.

DISCUSSION.

The PRESIDENT: I quite agree with the Author of the paper that the Local Government Board were not acting rightly in refusing to acknowledge the certificate of our Association, which certificate certainly proves that a man is capable of discharging the duties entailed by the office of building inspector. We hold that a man who passes our examination shows, as far as examinations can show, that he is capable of filling a higher position, namely, that of surveyor or municipal engineer. I hope we shall be able so to influence the Local Government Board as to induce that authority to reconsider the matter. I am quite certain that the Building By-laws Committee of the Council of our Association will give full consideration to the subject of local authorities having special Acts, and Mr. Prescott remarks upon that in force in Tottenham. I cannot understand why the Lea Conservancy Board should expect the payment of 1*d.* per 1000 gallons for water taken from the reach above the lock and returned below it, seeing that they get it all back. It seems to be an exorbitant charge. Morally, the Board are only entitled to an acknowledgment rent, and ought to be satisfied with that. I have seen the combined chemical fire-engine, hose-tender, fire-escape, and motor, and I think it is a most creditable piece of work. I have not yet seen it in operation, but it appears to me to be a thoroughly well thought out apparatus, and I shall be surprised if other towns do not copy it.

Mr. J. LEMON: I should like to move a hearty vote of thanks to Mr. Prescott for his admirable paper. There are one or two points upon which I should like Mr. Prescott to give the Members some further information. He tells us the Council have been able to reduce the rates. I congratulate the Tottenham Council upon their ability to do that. My experience is that rates are going up everywhere, and I believe it is the experience of nearly everybody; so if Tottenham are able to reduce their rates they are doing very well. I should like to know what the rates are in Tottenham. According to the paper they are 8*s.* 8*d.* in the £ altogether. Is that right?

Mr. PRESCOTT: 8*s.* 4*d.*

Mr. LEMON: Does that include water and County Council rates?

Mr. PRESCOTT: It includes the County Council and education rates, but not the water rate.

Mr. LEMON: There is one point in the paper that is rather a debatable one—that is the question of the by-laws. I am very glad that Tottenham has got a good local Act; but they must not be selfish in the matter, and prevent less fortunate districts getting equally good powers if they can. I do not think the Legislature is going to allow any more local Acts to be passed, because they want to secure uniformity throughout the country. We shall have to stick to the by-laws we have got, or go in and secure a general Building Act available throughout the country. Mr. Prescott seems to have arrived at the conclusion that if a general Building Act were passed, the local Acts would be repealed. The local authority at Southampton have got a local Act which the Local Government Board have tried to get them to give up, but they have always refused. I may also remind Mr. Prescott that all the good points contained in these local Acts might be incorporated in the general Act, and all the bad points omitted. I congratulate Mr. Prescott on selling his old tin for 17*s.* 6*d.* per ton. I do not know any one else who can do that.

Mr. S. G. GAMBLE: As an official of the adjoining county, and one of the old Members of this Association, perhaps you will allow me to most heartily second the vote of thanks. Mr. Prescott's remarks as to the unsatisfactory way in which the so-called unemployed do their work reminded me of a job I had in hand some eighteen years ago in constructing an open swimming bath, about 120 ft. by 60 ft., with labour of this type. The amount paid in labour was 380*l.* Mr. Prescott's estimate of the additional cost practically coincides with what I found in Lincolnshire where men of a similar type were employed. Mr. Prescott may well be proud of the go-ahead way in which Tottenham has tackled the question of motor appliances for fire brigade work, and I am sure you will be glad to know that the relations between Tottenham and the neighbouring districts are of an extremely pleasant and satisfactory kind. The statement that the motor fire-station at Harringay is the first of its kind in the world is erroneous, but I believe it is the first in England.

Mr. NORMAN SCORGIE: I have known Tottenham for the

last few years, and the improvements have been rapid and at the same time for the benefit of the inhabitants. Still one must look at the fact that the rates are rather high, and, if not so high as some of the neighbouring districts, they would do with being reduced if the unoccupied houses are to be let. Mr. Prescott has been more fortunate than most of us in his experience of red-gum blocks. Three years ago I put down a test piece of 1500 yds., and I wish I had never seen it. I think a good many of the London engineers are in the same unfortunate position. The system of simultaneous lighting of gas lamps throughout the district will be interesting to all of us. As to the making of private streets and the cost of 15*s.* per ft. run, Mr. Prescott does not tell us of what the work consists. I believe it is the rule of the Tottenham Council to require a foundation to be placed in the roads before the houses are built; also sewers and gullies to be constructed, and kerbs to be laid. If Mr. Prescott adds that to the 15*s.* it will amount to about 25*s.* per ft. of frontage. Districts vary in their practice as to what is charged. In London we have nothing but the virgin soil left for the builders. The houses are put up and then the authorities come in and lay out the streets, and do the whole of the work. This causes erroneous figures to be used in comparing prices, and makes it appear that outside districts can do the work cheaper than we can in London. If the whole of the facts were brought to the knowledge of the public it would be to the advantage of everybody. I would like to know if Mr. Prescott has the cost of collection of house refuse under the present method and the cost under a contractor, of course allowing a certain amount for the shoot. As to the bathing station, I congratulate Mr. Prescott upon two points: first, it is a great advantage to the district to have such a bath, and, second, it is an advantage to have the bathing station constructed above the outfalls of our friends at Walthamstow and Leyton. If he had gone a little further down he would not have taken 200*s.*, instead of 209*l.*, in the first twelve weeks.

Mr. A. J. PRICE: Mr. Scorgie has spoken about the cost of making up private streets. He says the cost per lineal ft. conveys no meaning to outsiders, because of the varying practice as to what is included in the work done, and it ought further to be mentioned that the width of the street—whether 30 ft., 40 ft., or 50 ft.—makes a great difference in the cost.

Mr. PRESCOTT: It is for a 40 ft. street.

Mr. PRICE: With regard to private street works, Mr. Prescott says they collect the money before they do the work. I do not see where the advantage is in that case of having 5 per cent. instead of 4 per cent. interest as other authorities have under the Private Streets Act of 1892. There is one other question. Have you power to charge 5 per cent. for superintendence and surveys as we have under the 1892 Act? There is no legal power under the 1875 Act to get it. Most people get it, but I do not think there is any legal power to get it. I was much interested in hearing Mr. Prescott's remarks about his building inspectors. It has been my lot to work as a building inspector for five years in a fairly large town, and I happen to hold the first-class honours certificate in building construction of South Kensington and the diploma of the Association of Municipal and County Engineers. Still in respect to their requirements I am not a fit candidate to come to the Tottenham Council as a building inspector. I have had many years teaching building construction, and many lads who have been through my hands are now Associate Members of the Royal Institute of British Architects, and while they were very strong artistically and æsthetically they were often very weak in constructional work, and unfit for the duties of a building inspector. One of the greatest difficulties I had was to get them to distinguish between tensile and compressive strains, and I could not drive graphic statics into them. Some of them could hardly tell a cast-iron girder from a rolled-steel joist. Still they would be able to come into Tottenham as building inspectors. It is one of the things that should be remedied, and I hope the Association will be able to do something in the matter. I should like to join Mr. Lemon in congratulating Mr. Prescott on being able to get 17*s.* 6*d.* per ton for his old tins. I cannot get 1*s.* a ton for mine. I am forced to put them under my road roller and work them into the foundations of my roads.

Mr. T. W. A. HAYWARD: I should like to ask Mr. Prescott to elucidate one or two points in his paper. Referring to the paving of the main roads, he says Jarrah blocks were used for the portion between the tramway metals and creosoted deals for the breasts of the road. Which of those two woods proved the better? Was the loan granted for the same period for both kinds of wood, and was the cost the same? I notice the cost is

lumped altogether at 13*s*. 9*d*. per yd. Referring to the red gum blocks, the cost is given at 15*s*. 8*d*. per yd. Does this include the same foundation as was used in the other cases? As to the rates of pay for workmen given in the paper, I should like to ask the number of hours worked per week; if the roller drivers have any extra time allowed; if the carmen have extra time for cleaning harness, etc.; does the term scavengers include street scavengers? I must congratulate Mr. Prescott upon the splendid arrangements for street lighting, and the simultaneous lighting of the gas lamps will further add to their value. With regard to private street works, I think Mr. Prescott has prepared an excellent specification, and if he will give the further particulars asked for by Mr. Scorgie, it will add to its value. I cannot see that the width of the streets is given. Some of our streets are made up to 40 ft. and some to 50 ft. Mr. Prescott says there are duplicate sewers provided in Tottenham. Does the 15*s*. provide for one or both sewers? Then Mr. Prescott states there are over 250 miles of public sewers in the Tottenham district, and in another part of the paper he says there are 60½ miles of roadways. Will he give us some explanation of how this length of sewers is made up? The paper states that the sewage is pumped into the London County Council's main sewer. I should like to know how the storm-water is treated. Passing on to the building by-laws, I notice that Tottenham enjoys special terms under their own Act. In the Metropolitan boroughs the Borough Councils have to pay the district surveyor who is appointed by the London County Council to see that their building work is properly carried out. I was very sorry to hear that the Local Government Board did not listen to the application to recognise the certificate of our Association. Did Mr. Prescott make application to the Council of the Association and seek their assistance when applying to the Local Government Board? I think the Local Government Board would take more notice of the Association as a body than of one Member applying in his individual capacity. I agree with Mr. Lemon, that if we could get a general Building Act, and it embodied all the best points of the private Acts, it would be a great improvement upon the present state of things. As to the dust destructor, I have been looking at the drawings to see the arrangement of the dust arrester. I should like to know whether that is a patented arrangement or one common

to the use of everybody. I should also like to know what the 1*s.* 7*d.* per ton includes. I agree that Mr. Prescott has done well with the disposal of by-products when he sells his old tins at 17*s.* 6*d.* per ton. I presume that what is meant is the pick of the tins after they have been sorted. One question as to electric lighting. Is it not a retrograde step to transfer powers from the municipality to a public company? I cannot see what is done now as to the provision of a permanent isolation hospital. With reference to the workshops, I should like some details as to what is done in them. I was rather struck by the fact that when the Council transferred their dust collection from the contractors to the works department of the Council, they bought carts. Could not these carts have been made in the Council's own workshops?

Mr. PRESCOTT, in reply, said: I am delighted with your exceedingly kind reception of the paper and for your vote of thanks. With regard to Mr. Lemon's observations as to a universal Building Act, Tottenham would be pleased if other authorities were successful in obtaining similar powers, but so for as my knowledge goes, when a clause is inserted in a Bill by a local authority seeking power to charge for the inspection of buildings, the blue pencil of the Local Government Board invariably strikes it out, and the authorities do not get it. That is an important matter, and one which ought to be taken into careful consideration when dealing with this question. As to the red gum blocks which were laid five years ago, I know some engineers have not had a happy experience of that particular wood. Perhaps mine might have been the same, but I rejected something like 50 per cent. of the blocks. I specially engaged an experienced timber man as clerk of the works, who examined every block and saw that the wood was as it ought to be. That is the explanation of why the work is in such excellent condition. As to private street works, it is not a fact that the Council insists upon a special foundation being put in the carriageway of a builder's road. All we do is to define the road by means of pegs. The 15*s.* includes the complete foundation in the roadways, kerbs, channels, and everything connected with the construction of the road. The minimum width of the roads is 40 ft.

Mr. HAYWARD: Does that include the sewers?

Mr. PRESCOTT: Certainly not. Coming to the dust destructor,

the collection is in the hands of the medical officer of health. The contract price was 6400*l*. per annum—that was for collecting and carting away to an outside district. The figure for collection is 2500*l*. The total cost of collection and burning of the refuse, and payment of interest and principal repayment of loan, is 7400*l*. As to getting in the money for private street works on the provisional apportionment, we never ask for more than one-third; the remainder is arranged with the treasurer, and, as a rule, we spread the payments over eighteen months. In reply to Mr. Hayward, I may say the carmen clean their own horses and harness, and the dustmen are paid at the rate of 28*s*. per week. The explanation as to the mileage of sewers is that we have a large mileage of sewers at the backs of houses. The figures given in the paper represent the combined drainage at the rear of houses and the duplicate sewers in the public highways. The storm-water is passed into natural watercourses. I did not seek the assistance of the Association in the matter of asking the Local Government Board to recognise the diploma of the Association. Perhaps I was wrong there: I shall know better another time. As to the dust arrester, there is no patent about it, being simply an ordinary arrangement of baffle walls. I again thank you most heartily for having listened to me with so much patience and attention.

Mr. Prescott then entertained the President and Members attending the Meeting to luncheon in the Hall formed by the new Swimming Bath adjoining the Municipal Offices.

The Members afterwards witnessed a Special Call of the Motor Fire Brigade, and the afternoon was occupied with visits of inspection to the Sewage Pumping Station, the Open Air Bath on Tottenham Marshes, Bruce Castle (the home of Sir Rowland Hill, the inventor of the penny post), and the East London Reservoirs of the Metropolitan Water Board.

EASTERN DISTRICT MEETING AT NEWMARKET.

May 5, 1906.

Held in the Town Hall, Newmarket.

A. E. COLLINS, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Chairman of the Urban District Council (Mr. Osmond E. Griffiths, J.P.), received the Members, and offered them a hearty welcome to Newmarket.

The President, on behalf of the Association, thanked the Chairman of the Council for the kind welcome he had offered them.

Mr. J. W. Cockrill was unanimously re-elected Honorary Secretary for the Eastern District.

MUNICIPAL WORK AT NEWMARKET.

BY JOHN W. METCALF, ASSOC. M. INST. C.E., SURVEYOR.

THE town was formerly governed by a Local Board of Health, consisting of twelve Members, which was formed in 1850 with an area of 540 acres, as shown in green margin on the Ordnance Map (displayed).

In September 1895 the Urban District was, by an order of the Local Government Board, extended as shown in pink margin, having an area of 5640 acres, divided into five wards with three Members for each ward, or a total of fifteen Members. This extension became necessary in consequence of building operations just outside the fringe of the old urban boundary in the

rural district of Newmarket which necessitated works of sewering, paving, lighting, etc. These advantages were not obtained, owing to the rural authority having in view its ultimate inclusion in the Newmarket urban area. Several attempts were made to include only the built-up portion on the outskirts, but the Local Government Board insisted on the whole of the parish of Exning being included in the extension, and it has now an area equal to many large towns.

The present population is 11,500, and the rateable value 79,417*l.*

The Council's indebtedness up to March 31, 1905, was 83,745*l.*, and the average general district rate for the last few years has been 4*s.* in the pound. A special rate of 4*d.* in the pound is levied on the old Urban area, producing about 750*l.* per annum; this is for the repayment of old loans under the order of the Local Government Board.

The number of inhabited houses in the Urban District is 2114, with an estimated population of 11,500 at the present time.

Health Statistics.

Although thirty years ago the town was visited with an epidemic of smallpox, it has since been remarkably free from the various infectious diseases; in 1903, however, smallpox was introduced in the centre of the town, but prompt isolation and other measures were immediately taken with the result that no spread took place; this we regard as satisfactory, seeing that we have a large floating population during the racing season.

The death rate for 1905 was a remarkably low one, being only 9 per thousand.

The total average death rate for the last five years has been 12·05 per thousand, and the average zymotic death rate 1·55 during the same period.

Street Improvements.

In the years 1891 to 1893 a very large number of the footpaths were laid down with artificial paving 2 inches thick, Victoria Stone, for which loans were obtained for a period of twenty years; the cost was 5*s.* 6*d.* per super. yard laid complete.

The loans sanctioned were 1500*l.*; 1763*l*; 2465*l.*; total, 5728*l.* These amounts were obtained at 3½ per cent. interest.

Roads.

At the present time there are 24 miles of district roads dedicated to, and repaired by, the authority. Leicestershire broken granite is chiefly used with a small quantity of local chalk flints for the outside district. The cost of granite averages about 11*s*. 6*d*. per ton delivered at the station. The cost of carriage by railway is accountable for about half this sum, and consequently the heavy cost necessitates a sparing use of the material.

It will be observed that it is a matter of some difficulty to get the roads up to a good standard owing to a general upheaval for purposes of sewerage. It is to be hoped, however, in another year or so a considerable improvement in their condition may take place.

There are no main roads in the district.

Private Streets.

During recent years several streets 36 feet wide have been made up under sec. 150 of the Public Health Act, 1875, the cost per lineal of frontage, including sewering, being from 11*s*. to 13*s*.; the curbing was 10 inches by 4 inches blue Pennant, channelling 12 inches by 3 inches.

One street (a cul-de-sac), with moderate traffic only, was made up nine years ago with limestone tar macadam on a rough cement concrete foundation, 8 to 1, 6 inches thick; the tar macadam was 4 inches thick, in two layers, the bottom layer 2¼-inch gauge and the topping 1 inch. The cost per foot frontage was 8*s*. 8*d*. exclusive of sewering, this being a general charge on the rates. The Members will have an opportunity of inspecting this street in passing to the sewage works. For streets of moderate traffic this kind of material is, in the Author's opinion, both economical and in every way satisfactory; during frosty weather, however, it requires more attention in sanding; but this is more than compensated for by the minimum of scavenging required, no mud being created in winter, and very little watering necessary during the summer.

Gas Supply.

The district is supplied with gas by the Newmarket Gas Company, the price to consumers being 3*s.* 8*d.* per 1000 cubic feet, the output being about 50 millions of cubic feet per annum.

Public Lighting.

The present street lighting is by means of 234 incandescent gas lamps, and 27 intensified lamps for the High Street. The total cost of the public street lighting is 928*l.* per annum, on a five years' contract.

The annual cost per lamp (including lighting, extinguishing, repairs, etc.) is: ordinary, 3*l.*; intensified, 6*l.* 5*s.*

Hours, 2000 per annum.

Electric Lighting.

In the Session of 1896 a local company was formed to seek a Provisional Order for the introduction of the electric light the Author advised, in a report dated March 7, 1896, the withholding of the necessary consent, and suggested to the Council the advisability of making application to the Board of Trade for the Order. On behalf of the town this was done, and the Order was subsequently obtained by the Council after severe opposition at a cost of about 300*l.* The Order was, however, transferred very shortly afterwards under the following terms:—

After the expiration of ten years, and at any time up to twenty-one years, the Council shall have the right of giving twelve months' notice to purchase the undertaking as follows:—

Capital reasonably expended plus 15 per cent. premium together with such sum as will make up 5*l.* per cent. per annum dividend.

After twenty-one years from date of transfer, capital expended plus 15 per cent. thereon.

If, at the expiration of forty-two years, the Council have not exercised their option to purchase, they shall then either purchase under section 2 of the Electric Lighting Act, 1888, or grant a further extension of transfer to the company on terms to be agreed upon, or settled by arbitration.

The Members will have the opportunity of inspecting the generating station, by the courtesy of the chairman and directors, and the manager, Mr. F. A. Simpson, has very kindly promised to explain briefly the progress of the undertaking since its commencement.

Water Supply.

The district is supplied with water by the Newmarket Waterworks Company from the chalk, and although somewhat hard is regarded as very pure. An analysis is given below :—

The Laboratory,
Tenison Road,
Cambridge.

Sample received from Newmarket Water Works Company.

The sample contained—

	Grains per gallon.
Total solid matter	24·00
Chlorides	1·40
Equal to chloride of sodium (common salt)	2·30
Nitrates (expressed as nitrogen)	·30
Ammonia (free)	trace
„ (albuminoid)	trace
Oxygen absorbed by organic matter in 15 minutes at 140° F.	·0122
Appearance in 2-ft. tube	clear pale blue
Smell, heated 100° F.	none
Metals	none
Microscopic examination	no deposit

Remarks :—

Total solid matter, chlorides and nitrates are all low and quite satisfactory. Free and albuminoid ammonia and oxygen absorbed are all extremely low, and show the absence of organic matter.

I consider the water is unpolluted and quite fit for drinking purposes.

(Signed) J. West Knights,
Public Analyst.

March 3, 1905.

Scale of charges for domestic purposes: 6*l.* per cent. per annum up to a rental of 70*l.*

70*l.* and under 80*l.* per annum: 4*l.* 4*s.* a year, and 10*s.* per annum for every additional 10*l.* rental.

Additional water-closets	5*s.* a year
Baths	8*s.* „
Gardens	20*s.* „
By meter, up to 50,000 gallons a quarter	1*s.* 6*d.* per 1000 gals.
„ over „ „	1*s.* „

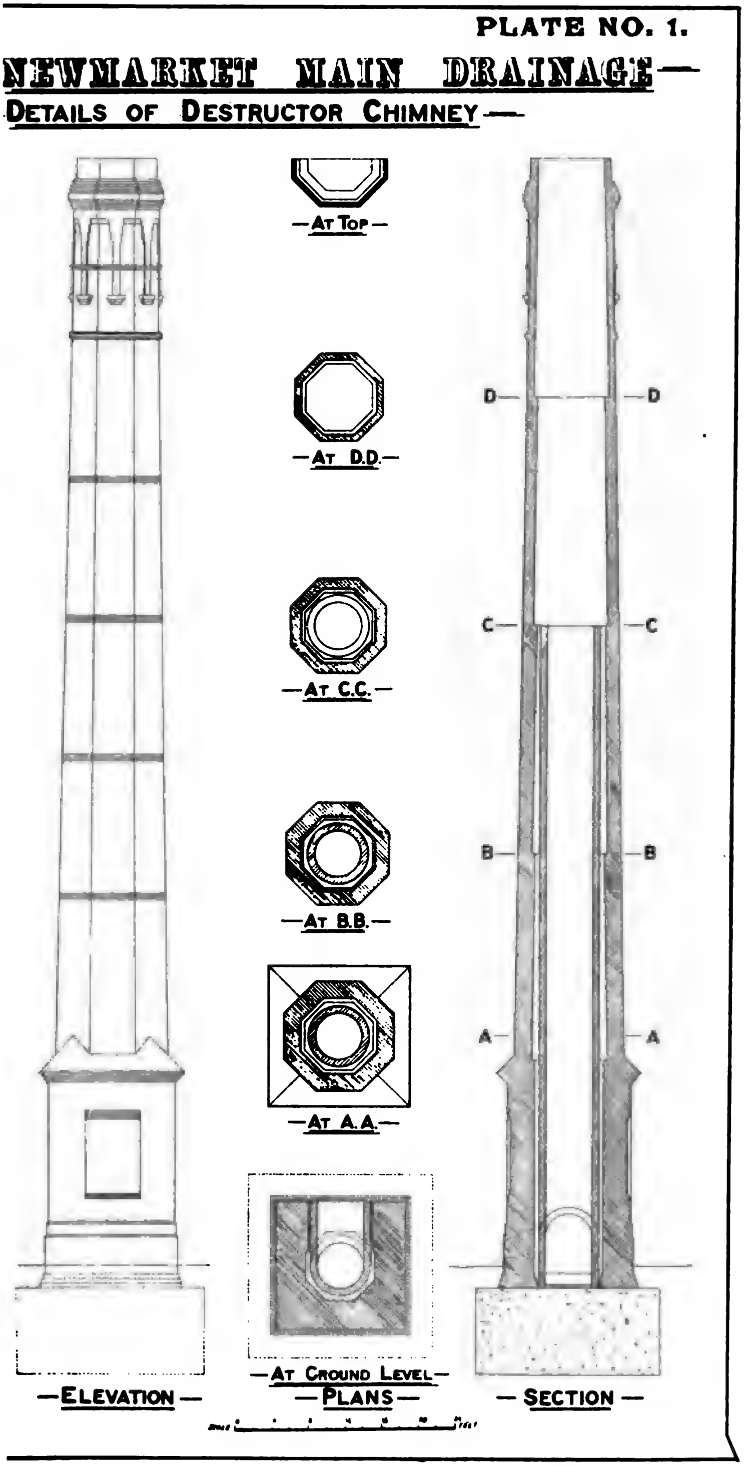


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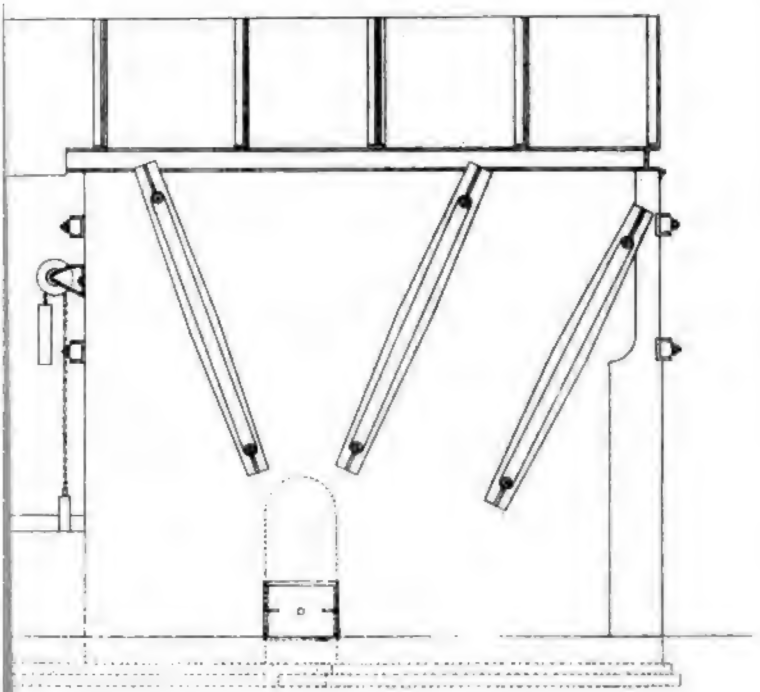
PLATE NO. 2.

AGE —

WATER TUBE BOILER —



— SIDE ELEVATION OF CELLS —

"PHOTO-LITHO" R. J. EVERETT & SONS, 19, BARTLETTS' BUILDINGS, HOLBORN CIRCUS, E.C.

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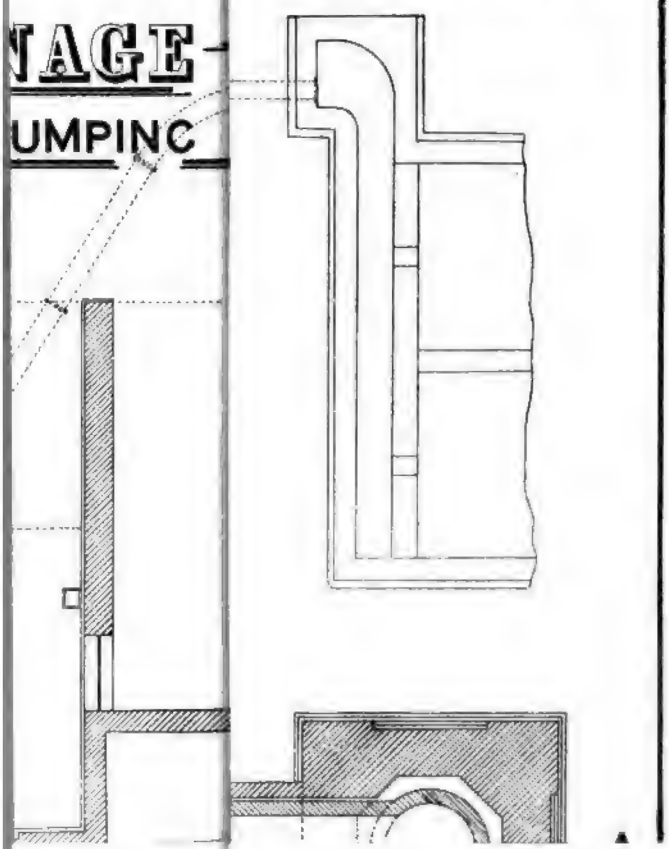
PLATE NO. 3.



House Refuse.

A weekly collection of house refuse is made by the Council's carts, and in the more densely populated parts of the town, more frequent visits are made; the total quantity collected per annum is about 2000 tons. Trade refuse is not collected by the Council.

Fire Brigade.

Two private fire brigades existed in the town; the Volunteer and the Trainers and Owners. These are now being taken over by the Council and re-organised. Additional fire hydrants are now being fixed for the better protection of the town, and a fire escape and other appliances are under consideration. The total number of hydrants available for fire purposes is 46 at Newmarket, and 8 at Exning. A good pressure of water is available, the head being about 200 feet in the centre of the town opposite the General Post Office.

Cemeteries.

There are two cemeteries in the district, one for Newmarket and one for Exning.

Sewerage.

In the year 1875, Mr. Baldwin Latham, M. Inst. C.E., designed and submitted a scheme of sewerage and water supply for the old local board area, having its sewage outfall a little lower down the valley than the present sewage farm. The water supply scheme was not entertained at the time, and a few years afterwards a private company was formed for the purpose of securing a Provisional Order to supply the district with water, the necessary powers being obtained in the Session 1882. The sewerage scheme was revised and carried out by the late Mr. John Francis Clark, of Newmarket, having its outfall on 9 acres of land which is the site of the present works, the area of the land which could be irrigated being about 5½ acres, and this continued in operation until the Urban District was extended in the year 1895, when it became necessary for the authority to consider the question of a comprehensive system of sewerage and sewage disposal for the whole of the district.

In 1896, at the request of the Council, the Author was instructed to report and prepare a general scheme, which was duly submitted in June of that year. By careful levels, it was ascertained that a gravitation scheme was possible, but this entailed about half a mile of tunnelling at a great depth. The Council, after consideration, decided to call in the late Mr. Frederick Beesley, M. Inst. C.E., of Westminster, who approved the recommendations with certain modifications in March 1897; the result being that the scheme was adopted by the Council and instructions given to apply to the Local Government Board for inquiry and the necessary sanction to a loan of 45,000*l.* to carry out the work.

The inquiry was held in April 1898, by Mr. Meade-King, M. Inst. C.E., the Council's application being strenuously opposed by the Burwell Fen Drainage Commissioners. The application failed owing to the existence of an old Act of Parliament held by the Commissioners, which precluded the taking of water from one watershed to another, and the Commissioners' terms and conditions were, in the opinion of the Council, unreasonable; consequently, this scheme was abandoned.

Mr. F. Beesley having been appointed engineer for the scheme, he was instructed to prepare another to include the provision of a refuse destructor, and a pumping scheme became necessary. After careful consideration, the Council decided to enlarge the present sewage farm, and a Provisional Order was sought to acquire an additional 4 acres of land from the Jockey Club; this was obtained and a further 4 acres taken by agreement, making a total area of the Newmarket outfall site of 17 acres. The sewage is collected and conveyed to this site, which is a distance of about a mile below the town, reaching the works at a level of 67·50 O.D. Commencing at the outfall, a culvert 4 feet internal diameter, for night storage, is constructed having a capacity of 30,000 gallons from this point up to the centre of the town; the main sewer is 18 inches in diameter. The tributary sewers are of glazed socketed pipes, and vary in size from 15 inches to 7 inches, and comprise about 15 miles.

All the new sewers are laid in straight lines at self-cleansing gradients with manholes at changes of direction and at all junctions, generally not more than about 100 yards apart, the

foul sewers being laid on a bed of cement concrete, and wherever practicable, tested with water test; the old sewers being retained as far as possible and utilised for storm water diverted to the natural main water-course.

The house drains hitherto connected to old sewers were disconnected and joined up to the new sewers, taking the drain back to the building as far as necessary to make a good connection owing to the difference in the levels. The disconnecting trap is always put in new drains, and where practicable a chamber is built for purposes of access to the trap. Provision was made for flushing the sewers by means of automatic flushing tanks placed at convenient points, of 500 gallons capacity. The connections to the town's water mains were made in the usual way, with a stop-cock and trap in between; but the company afterwards refused to supply the water in this manner, owing to the danger (as alleged) of polluting the water supply with sewer gas. The result of the disagreement ended in the Council severing the connection, and the tanks are now filled by the water-vans with water taken from the Council's street watering station.

Ventilation.

The sewers are ventilated by means of cast-iron columns, 8 inches in diameter, 23 feet high, and also by 6-inch by 4-inch steel tubes, carried up above the eaves of buildings and clear of windows. Under agreement with the owner and occupier of the property, a nominal rental of 2*s.* 6*d.* per annum is paid by the Council in most cases, and an undertaking given to remove them on receiving three months' notice.

Exning Sewers.

The ground at Exning is water-logged, and much difficulty was experienced in laying these sewers; the ejector station in particular was a very costly item on account of continuous pumping.

Bacteria Beds.

The sewage is delivered from the rising main into the screening chambers, which are in duplicate, where it passes through a

1-inch, ½-inch and ¼-inch mesh screen, and from thence into the upper main carrier. Every week the sludge which collects in these chambers is lagooned to a depth of about 3 inches on well drained land, the Council using a portion for manuring the crops, the surplus being easily disposed of to farmers at 1s. per load at the farm. The coarse beds, which are ten in number, are filled from the upper main carrier by means of Messrs. Adams and Co.'s automatic filling apparatus, the sewage flowing along grips, formed in the surface of the filling, which is a hard clinker obtained from gas works. The beds average 4 feet depth of material, and a fall of 6 inches is given in floor towards the outlet. The underdrains are formed of 4-inch agricultural pipes. The sewage is held up in these beds by means of timed syphons for a period of two hours, when it is discharged on to the fine beds, where it is again held up for two hours in a similar way. The filling of the "fine" beds is coke breeze, and the average depth 4 feet, the beds having a fall and underdrained in the same manner as the coarse beds. The effluent is discharged into the lower main carrier, from which it runs over the land.

—	*Newmarket* Outfall.		*Exning* Outfall.	
	Coarse.	Fine.	Coarse.	Fine.
Number of beds ..	10	10	10	10
Size	50 ft. by 48 ft.	53 ft. by 50 ft.	28 ft. by 23 ft.	31 ft. by 23 ft.
Depth	4 ft.	4 ft.	4 ft.	4 ft.
Area of each bed	266 sq. yds.	294 sq. yds.	72 sq. yds.	79 sq. yds.
Total area	2660 sq. yds.	2940 sq. yds.	720 sq. yds.	790 sq. yds.
Cost per yard super.	1*l.* 10*s.* 9*d.*		2*l.* 3*s.* 9*d.*	

The Newmarket beds are constructed of cement concrete, 6 to 1 chiefly, and faced with cement concrete blocks, 2 to 1 facing ¾ inch thick of ¼-inch granite chips, the backing 6 to 1, properly bonded together; the blocks are 14 inches long by 7 inches and 6 inches thick. Local gravel was used for the concrete, which cost about 6*s.* per cubic yard delivered on the site.

The Exning beds are constructed of cement concrete 6 to 1 throughout, faced with blue Staffordshire bricks, and coped with blue Staffordshire bull-nosed coping.

SEWAGE FARM.

The crops grown are chiefly for the Council's horses, and include mangel-wurzel, kohl rabi, sainfoin, lucerne, and oats in the usual rotation, any surplus beyond the requirements of the Council is sold to farmers and trainers at the usual market rates.

The land has not been recently underdrained although some of the old drains still exist and are working; but the Local Government Board considered that the underdraining was not necessary at present, and, therefore, the work originally proposed was not carried out.

At Exning no underdrains exist, and, therefore, we are not troubled with any effluent discharge into the stream.

SEWAGE PUMPING STATION, ETC.

The buildings comprise an engine house, measuring 30 feet by 24 feet, containing 15 H.P. horizontal engines in duplicate, working under a steam pressure of 90 lb. per square inch, having a steam cylinder 10 inches diameter and 20-inch stroke, fly-wheels 7 feet in diameter; each engine drives a 10-inch centrifugal pump, capable of raising 1600 gallons of sewage per minute a height of 23 feet.

Two steam air-compressors, one provided for raising the sewage at the Exning outfall 2 miles away by means of two 200-gallon ejectors. The compressors are horizontal high speed non-condensing, air cylinders water jacketed, air inlet and outlet valves of the Corliss type; they work under a steam pressure of 120 lb. per square inch, and raise the sewage a height of 33 feet.

The external walls of all the buildings are of Heather pressed bricks, the engine house having a salt glazed brick dado internally. The destructor house, which is 46 feet by 43 feet, contains a two-cell refuse destructor, by Messrs. Manlove, Alliott and Co., with a Babcock and Wilcox water tube boiler between; a Cornish boiler, 16 feet long, 4 feet 6 inches diameter, is also provided for stand-by purposes; the building is made large enough for an extension of two more cells.

The chimney shaft is 120 feet high above ground level, octagonal in shape, with a circular fire brick lining to a height of 70 feet, and rests on a foundation of concrete 20 feet by 20 feet by 10 feet thick.

Stores, offices and three workmen's cottages are also provided.

Cost.

Contract No. 1 (Exning).

	£	s.	d.
Sewers, manholes, flushing chambers, ventilation, etc.	6653	11	9
Surface water sewers	1721	7	7
Ejector chamber and ejectors	2465	17	7
General items	338	16	6
	£11,179	13	5

Contract No. 2 (Newmarket).

	£	s.	d.
Sewers, manholes, flushing chambers, ventilation, etc.	21,122	2	8
Surface water drainage	5,230	10	7
General items	3,937	13	3
	£30,290	6	6

Contract No. 3 (Sewage Pumping Station, Etc.).

	£	s.	d.
Two 15 H.P. horizontal engines and centrifugal pump	703	10	0
One Cornish boiler	303	6	0
Two-cell destructor with Babcock water tube boiler	1755	0	0
Two steam air compressors, etc.	529	1	9
Chimney shaft, 120 feet high	992	4	4
Inclined approach	955	7	4
Buildings, comprising destructor house, engine house, stores, and office	3551	16	9
Cottages for workmen..	1606	12	7
General items	68	2	2
	£10,465	0	11

Bacteria Beds.

Newmarket.

	£	Local Government Board Estimate.
Cost of works	6537	..
Clinker and breeze filling	1630	..
Adams and Co's. contract for automatic apparatus	435	..
	£8602	£11,500 0 0

Cost per yard super .. .. 1*l.* 10*s.* 9*d.*
Cost per acre .. .. .. 7441*l.*

Exning.

Cost of Works..	3025	..
Clinker and breeze filling	486	..
Adams and Co's. apparatus	320	..
	£3831	£5000 0 0

Cost per yard super.. .. .. 2*l.* 3*s.* 9*d.*
Cost per acre .. .. .. 10,589*l.*

SUMMARY OF ACTUAL EXPENDITURE.

	£	s.	d.
Contract No. 1	11,179	13	5
" No. 2	30,290	6	6
" No. 3	10,465	0	11
Bacteria beds	12,433	0	0
Engineering and quantities	3,950	0	0
Resident engineer and inspectors	1,370	16	0
Purchase of land	2,277	5	2
Counsel's fees and legal expenses	359	8	0
Expert evidence	696	0	3
Easements	2,201	11	0
Printing	208	8	6
Establishment and sundries	6,068	10	3
	£81,500	0	0

The periods for loans sanctioned were as follows:—

Land	50 years
Sewers, ejector station, and bacteria beds	30 "
Destructor house Refuse destructor Engine house Chimney	20 "
Engines and pumps Air compressors Cornish boiler	30 "
Stores and office	30 "

The works have been carried out as follows:—

No. 1 Contract (Exning Sewerage), including ejector station, by Mr. W. Manders, of Leyton, Essex.

No. 2 Contract (Newmarket Sewers), by Mr. H. J. Linzell, of Newmarket and Felixstowe.

No. 3 Contract (pumping station and destructor), by Mr. H. J. Linzell.

The ejectors, air compressors, and air mains, by Messrs. Hughes and Lancaster, Ruabon and London.

The engines, centrifugal pumps, rising main, 2-cell destructor, and boilers, by Messrs. Manlove, Alliott and Co., Nottingham.

The engineers to the Council were, Messrs. Beesley, Son and Nichols, Civil Engineers, Westminster, S.W.

Mr. F. Sanderson-Robins, Assoc. M. Inst. C.E., carried out the duties of resident engineer.

The bacteria beds at both outfalls were carried out by administration under the Author's supervision, assisted by Mr. W. I. Tait.

The Author regrets that pressure of work has not permitted preparation of a more exhaustive paper, but he will do what he can to furnish any other particulars wished for, that may be of interest to the Members.

DISCUSSION.

The PRESIDENT: The rateable value of Newmarket is about 7*l.* per head of the population, which is very high. In Norwich our rateable value is about one-half that of Newmarket per head of population, and as a result of that low valuation our rates seem very high, whereas they are really moderate, and practically about the same per head of the population as Newmarket. The town deserves to be congratulated on its health statistics, as shown in the paper. It is a very satisfactory thing to see the death rate so low as twelve per thousand for the last five years. There are very few towns in the country that can show so low a death rate. With regard to street paving, I notice that Mr. Metcalf has used tar macadam for street works for a period of nine years. One of the earliest towns to use tar macadam was Weston-super-Mare, where it was laid about forty years ago, on, however, a different system from that generally followed. The surface of the road to be covered with tar macadam was first swept entirely free from all loose material, and then painted with tar boiled to such a consistency that a drop taken between the finger and thumb would draw out like cobblers' wax. That was covered with stone broken to 1½ in. gauge, which was laid one stone thick, then sprinkled with tar, after which another layer of limestone was laid. The stone was not heated; it was only dried. If a thicker coating were required, then further layers of tar and stone were put on. At Weston the work was usually done with two coats of stone and tar, with a top dressing of limestone gravel, after which the road was rolled. I have known tar macadam to be laid there at a cost of 1*s.* per square yard. A road made in that way will stand light traffic for five or six years. That was the procedure adopted in Weston-super-Mare not only for roadways, but for footpaths, when I was there about seventeen years ago, and it was very successful indeed. I was amused when I heard tar macadam spoken of as something entirely new, when to my own knowledge it has been

in use for forty years. I must warn you that tar macadam is good, only under certain circumstances. It is not good either for very heavy or very light traffic, but it is good for streets which have a medium traffic. The cost for street lighting is very high for lamps which are lighted only 2000 hours per annum. In Norwich the lamps are lighted for 4000 hours for about the same cost. We have not the price paid for water for street watering purposes.

Mr. METCALF: A shilling per thousand gallons.

The PRESIDENT: I notice you put disconnecting traps on the house drains. Did the Local Government Board insist upon that, or has it been done of your own volition? I notice you screen your sewage through a very fine mesh before it goes on the final carrier, and that the chimney shaft, which is 120 ft. high, cost 992*l*. That seems a very high price for so small a chimney.

Mr. T. W. A. HAYWARD: I hope the members of the Urban district council will not take too much notice of the President's remarks as to tar macadam, namely, that it can be done at Weston-super-Mare for 1*s*. per square yard.

The PRESIDENT: I am glad you mentioned that. I ought to have qualified it by a reference to the cost of the material.

Mr. HAYWARD: I think we ought to congratulate Newmarket on the splendid health statistics given in the paper. I do not remember ever seeing a lower death-rate in any other town. The deaths for the last five years have only averaged twelve per thousand, and for the last year are as low as nine per thousand. That testifies to the good health of the district, which I attribute to an efficient sewerage system. I should like to ask Mr. Metcalf whether any repairs have been necessary to the artificial paving laid in 1891 and 1893? I am not speaking of work caused by the breaking up of the footpaths for sewerage and other connections, but actual repairs caused by wear. Many of us would like to follow Mr. Metcalf's example, and obtain loans for a period of twenty years, but I am afraid we cannot do that at the present time. If the Author could give us some information as to the life of this artificial stone, it would be useful when applying for loans for paving. I quite agree with Mr. Metcalf that it is difficult to keep up a good surface on the roads when they are so frequently broken up, and when so high a price has to be paid for stone. Perhaps it is a misfortune for Newmarket that it has no main roads, but in that respect you are in the

same unfortunate position as other towns in West Suffolk. My opinion is that the roadways of the future will be largely made of tar macadam. I cannot, however, agree with the President when he says that tar macadam is not suitable for heavy or for very light traffic. I have one road which has been made for two years, and subjected to some of the heaviest traffic in London, and it is as good to-day as it was when it was put down. I have also streets which have been made for two years, and in which the traffic is very light, and those are in equally good condition. I think the Council would have been well advised if they had acted on the recommendation of the engineer, and kept the electricity supply in their own hands, and it would have been a decided advantage if the sewage pumping station, the destructor, and the electricity works had all been erected on one site. With regard to the collection of refuse, I think that for a small town like Newmarket, Mr. Metcalf has made excellent arrangements both for collection and disposal. I notice that the part of the sewage-disposal works done by directly employed labour, under the supervision of the surveyor, showed a saving of 40 per cent. on the estimated outlay. That is an excellent result. I think Mr. Metcalf is also to be congratulated on being able to sell the surplus manure from the collecting chambers at 1*s.* per load, and to get it carted away. The cost of constructing the bacteria beds has been rather excessive, but the cost of carting the major portion of the material has to be taken into account. I have pleasure in proposing a hearty vote of thanks to Mr. Metcalf for his paper.

Mr. A. M. Fowler: With reference to the remarks of the President as to tar macadam, he has omitted to tell us that the stone should be superheated before putting any tar on it. The President has spoken of the recent experiments of tar macadam. At Scarborough, and also at Buxton, the results obtained with tar macadam are excellent. I do not think there is any better method of road-making, for rural districts, than tar macadam when done in a scientific manner. With regard to asphalt-concrete foundation to roads not standing heavy traffic, I might say that in the vegetable market at Leeds, where there is some of the heaviest traffic in the city, I laid down a tar-macadam foundation. The paving stone surface wore almost right down on to the foundation, which was just as perfect as when it was put in. Therefore I came to the conclusion that

tar macadam, or tar concrete, as we might call it, makes a better foundation than ordinary concrete. It is impervious to water, and very strong indeed. I have pleasure in seconding the vote of thanks.

Mr. NORMAN SCORGIE: I am inclined to agree with the remarks of the President as to tar macadam, and hope the Members who will visit Battersea a fortnight hence will be convinced to a greater extent than I was when there some months ago. Some of us have to put granite down, and find it will not stand the heavy traffic of which Mr. Hayward speaks, therefore I fail to see how he will get the wear out of slag. (Mr. Hayward: Slag is harder than granite.) I must admit that some of Mr. Hayward's roads are very good, but others have a scabby surface. Mr. Metcalf tells us that the public street lighting costs 928*l.* per annum. He also gives the number of lamps, and states that the price of the 234 ordinary incandescent street lamps is 3*l.*, and of the 27 intensified lamps, 6*l.* 5*s.* per annum. If you work that out you will find the total cost is only 870*l.* 15*s.*, or a difference of 57*l.* 5*s.* from the amount stated. I agree with the President that the charge of 3*l.* per lamp per annum is excessive, especially with gas at 3*s.* 8*d.* per 1000 cubic feet. I presume that the incandescent lamp in use is the ordinary lamp burning 4¼ cubic feet per hour, which gives a total consumption for 2000 hours of 8500 cubic feet. The cost of gas, therefore, works out at 31*s.* 2*d.*, so we have another 28*s.* 10*d.* per annum for lighting and maintenance—an exceedingly excessive charge in my opinion. Even with the small number in use it ought to be done for 1*l.* per annum. As to the electric lighting, I am pleased Mr. Hayward made the remarks he did about handing over the provisional order to a company. It is a mistake to do so, even though it might not be worked at much profit, which I presume is the case, because I read in the "Contract Journal" of May 2, that the company is only supplying 20,000 8-candle-power lamps. One has to have a day load as well as a night load, and I suppose there are no manufacturing industries in Newmarket which will take a day load. There is no doubt it is the day load which makes or mars an electricity undertaking. In Hackney we are fortunate in our day load so as to be able to make a profit of 4000*l.* to 5000*l.* per annum, and we are increasing our power load.

The PRESIDENT: I think it is necessary to add to my re-

marks as to the cost of tar macadam. I should not like it to go forth that tar macadam can, in the ordinary way of things, be laid for 1s. per yard. At Weston-super-Mare we had the stone for the getting, and the tar at a very low price. It was a place where there was a poor market for tar.

Mr. E. J. Silcock: The Newmarket Council are to be congratulated upon having sewage works which turn out a very good effluent. The only criticism one can offer on the sewage works is that they are very effective, but the question is whether they are not more expensive than was absolutely necessary. In dealing with a town like Newmarket, where the rateable value is exceedingly high, perhaps the Council were justified in going to an expenditure higher than they would be in a town of larger population but lower rateable value. But after all we must remember that it is the population and not the rateable value which makes the sewage. The dry weather flow appears to be about 300,000 gallons a day, 250,000 at the Newmarket and 50,000 at the Exning works. The area of the beds, taking the first contact beds and the second contact beds together, is 7110 square yards, which, for a dry weather flow of 300,000 gallons, seems unduly large. Having regard to the fact that the sewage has to be pumped, and the beds are each 4 ft. deep, I am of opinion that equally good results could have been obtained by placing the coarse and fine beds one on top of the other, making them 8 ft. deep, and working them as trickling filters instead of as contact beds. If that had been done, 2000 yards of beds would have been sufficient, which would have been equivalent to 4000 yards, 4 ft. deep, as against 7000 yards in the present works. The cost of construction of the 2000 yards would have been considerably less than the 7000 yards, as there is only one floor to a bed, whether it be 8 ft. deep or 4 ft. Take it all round, I do not think the cost would have been much more per yard than the present beds. It is, of course, easy to criticise works when they are finished, and at the time when these works were constructed the Local Government Board were very severe in their requirements, particularly as to contact beds. I must say that the position taken by the Board has been largely justified by the results, because we find that the quantity of water which can pass through a contact bed is limited by the capacity of the bed itself; and when you have storm-water and sewage mixed, you are obliged to provide capacity for three

times the dry weather flow, and a certain time for the contact, otherwise purification does not take place. With a trickling filter you can deal with a larger quantity, and the same result can be obtained, because you are able with continuous beds to run them at a much higher speed than you can contact beds. Then there is the question of the sludging up of contact beds, which is a very important matter to bear in mind. I saw signs of sludging up in the Newmarket beds. When sludging does take place, the filtering material will have to be taken out and washed and replaced, and during that time the bed will be out of work. Therefore, with contact beds you must provide extra area to do the work during cleansing. There again you have an important factor in deciding as to the area of the beds to be provided. The total cost of the works appears to be about 7*l.* per head of the population, which, I think, comparing the cost with that of other towns, is a very high figure. It is perfectly true the installation includes a destructor, but making a deduction on a high scale for the destructor, it leaves the cost of the sewage works at 75,000*l.*, or about 6*l.* per head.

Mr. C. J. JENKIN: In dealing with this question of cost, it would be an advantage if we could have the price of local labour, and also of materials. With regard to private street works, I should like to know what is included. I notice Mr. Metcalf says the channelling is 12 in. by 3 in. On what is it supported?

Mr. METCALF: It is laid on concrete.

Mr. JENKIN: As to public lighting, I agree with the other speakers that the cost is very heavy. I should like to know whether it includes mantles, painting and upkeep of columns.

Mr. METCALF: It includes all maintenance, painting and repairs.

Mr. JENKIN: I should also like to know the type of pipe laid at Exning, the price per yard, and whether they were successful in dealing with the waterlogged ground. In dealing with the sewage, though the land is not underdrained, I take it there must be an effluent, and, as you are pumping water from a similar strata, although I judge from the ordnance levels that it is higher than the sewage works, there may be a risk of the contamination of the water supply. I do not know whether the chalk is sufficiently solid to prevent any connection between the two.

Mr. F. W. KNEWSTUBB: I notice that the Local Government

Board has sanctioned a loan for the destructor of twenty years, and for the engines and boilers of thirty years. That seems a rather unusual arrangement. I always thought that for machinery and boilers, a shorter period of repayment was granted than for buildings. I should like to know if that is the case. With regard to main roads, the towns in West Suffolk seem to be in a very unique position. In Haverhill, we are also in the unique position of having two miles of main roads in a county which has no other urban main roads; but that is probably due to the fact that these particular roads connect the main roads of Essex and Cambridge, which seems to account for our having main roads while the other local authorities have none. At present we have a dispute with the county council, who are repairing the roads themselves. I should like to know whether the gas company make any reduction to large consumers, and also to those consumers who use gas for power purposes.

Mr. GLADWELL: With respect to the sewage works, I find myself in entire agreement with Mr. Silcock in his views as to the apparently large expenditure which has been incurred in connection with these works. I find, taking the superficial area of the beds, as given in the paper, that there are sufficient coarse beds to deal with the sewage of over 19,000 persons at 30 gallons per head per day. While on that point I should like to ask what is the water supply per head per day from the waterworks.

The CHAIRMAN OF THE WATERWORKS COMPANY: About 28 gallons.

Mr. GLADWELL: Assuming that to be treated at the outfall figures, it would appear that the necessities of Newmarket have been overestimated rather than underestimated. I also agree in thinking that continuous filters would have been better than contact beds. Probably when these works were designed, contact beds were more favoured than the other form of filter. I should also like to ask whether we can have any information with respect to the maintenance cost—the general maintenance of the sewage works. With respect to the main road question, I certainly do think that West Suffolk is notorious among other counties of the Kingdom, from the fact that there are practically no main roads. It appears to go to one extreme; while other counties go to another extreme, and make any road main they are

asked to. I do not know which is the more ridiculous, but I am inclined to think it is West Suffolk. The local authorities up and down the country are suffering from a very bad attack of "county council," and, so far as I am concerned, I should like to see their (the county council's) wings clipped considerably, while greater responsibilities and duties should be placed upon local authorities, who are quite as capable of looking after their work as county councils are for them.

The PRESIDENT: With regard to the life of engines and boilers, I am now in charge of some engines which have been running thirty-six years, and I think they are rather better to-day than the day they were started. I have also four Lancashire boilers, put in at the same time, and although they ought to be worn out they are not, but are still working at the same pressure as when they were first put in. You will see from this, that so far as the period of loan allowed by the Local Government Board is concerned, there is nothing unreasonable in it.

Mr. TROUGHTON (Gas Manager): Mr. Metcalf has rather under-estimated the number of public lamps. We have an extra thirty-seven lamps, which are lighted 2000 hours per annum beyond the average mentioned. Then we have twenty-seven intensified lamps, which use on an average 12 cubic feet of gas per hour, or equal to three ordinary lamps. That is a very large item in regard to the average. If you include these, the price is brought down to 2*l.* 14*s.* per lamp per annum. This includes lighting and extinguishing, repairs and maintenance, and the plant is the property of the gas company Another speaker asked as to the price of gas for motive p wer. We do supply it at a cheaper rate. The price is 3*s.* 4*d.* per 1000 cubic feet for power, and 3*s.* 8*d.* for light.

Mr. J. W. METCALF, in reply, said: With regard to the disconnecting traps on house drains, that applies to new connections, and not to the connections from the old drains. Mr. Hayward inquired as to the upkeep of the patent stone paving. There has been no charge for maintenance, except where disturbed for gas or water pipes. The paving in the main streets has been down since 1891 and 1892. Mr. Hayward also referred to the position as to main roads in West Suffolk. I believe there are only about 16 miles of main roads in West Suffolk. Some years ago an effort was made to bring Newmarket into Cambridgeshire, and this question of main roads was one of the arguments

in favour of the transfer. The principal street here is the main road from London to Norwich. Mr. Silcock has criticised the method of filtration of the sewage, and has expressed a preference for continuous filtration over contact beds. At the commencement, we put down experimental artificial filters 3 ft. deep, at a cost of about 800*l.* per acre. They gave an effluent of about 40 per cent. of purification, and to my mind they were satisfactory. It was argued that we could get more work done by contact bacteria beds. The Local Government Board were not satisfied with the above filters, and considered that the results did not come up to the requirements of Newmarket. The filtering media for the coarse beds has cost us 10*s.* per ton delivered at the site, and the coke breeze about 7*s.* 6*d.* per ton. Mr. Jenkin raised a question as to the cost of local labour. That would not materially affect the total cost. There was practically no local labour employed; it was all imported labour. As to the underdraining, that was included in the scheme; but the Local Government Board said it was not to be done, and at Exning you have seen evidence that it was not necessary. I certainly do not think there is any danger of contamination of the water supply. With regard to the period of the loans, the statement in the paper is quite correct—thirty years was granted for the machinery, and twenty years for the buildings. I could not understand why only twenty years was allowed for the buildings. The analysis of the effluent by Mr. J. West Knights is as follows: Total solids (mineral, 32; organic, 6), 38 grains per gallon; chlorine, 4·7, equal to chloride of sodium, 7·74; nitrates (expressed as nitrogen), 0·55; ammonia (free), 1·155; ammonia (albuminoid), 0·095; oxygen absorbed, 0·546; suspended matter, 1.

The Members were entertained to luncheon by Mr. C. E. Griffiths, Chairman of the Council, at the Victoria Hotel. On the proposition of Mr. W. Weaver, a vote of thanks was passed to Mr. Griffiths for his hospitality.

The Members had the privilege of visiting the rooms of the Jockey Club, the Rous Memorial Hospital, the electricity supply works, the Newmarket and Exning sewage disposal works, the waterworks, and the racecourse.

At the conclusion of the visits, Mr. J. W. Metcalf hospitably entertained his fellow Members to tea.

METROPOLITAN DISTRICT MEETING AT BATTERSEA.

May 19, 1906.

Held in the Council Chamber, Battersea.

A. E. COLLINS, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Mayor of Battersea (Mr. W. Rines, J.P.) cordially welcomed the Association, and said the Corporation felt very highly the compliment which the Association was paying in visiting the borough.

The PRESIDENT OF THE LOCAL GOVERNMENT BOARD (the Right Hon. John Burns, M.P.): Gentlemen, I welcome you with the Mayor this morning—first as an engineer to my native parish, secondly as a Member of Parliament to my constituency, and thirdly, if I may say so, as your official chief as President of the Local Government Board. In these three capacities I am pleased to be present at this gathering of engineers and surveyors, whose efforts, energies and capacities place the community under a lasting debt of obligation to them. Your profession—which is my own—is indispensable to the large aggregations of mankind in town and city. Your work, with that of the medical officer, is the basis of that public health without which large communities cannot exist, and I congratulate the English engineers and surveyors on the excellent strides they are making through their profession to raise the standard of British municipal sanitation, not only to the first place that it occupies in the world, but to maintain the best traditions that we English people have of being the pioneers of health and sanitation, and in so being the model and exemplar for the rest of the civilised world. You, gentlemen, are often criticised by the indignant ratepayer, by the uninformed journalist, and frequently by public men, who do not understand, and therefore cannot appreciate, the difficul-

ties under which you carry out your interesting and fruitful labours. The council in the first instance decides what shall be done, the ratepayer sometimes cheerfully assents, but he more frequently grumblingly pays, but it is on your shoulders and through your hands and your minds that the ratepayers' money and the council's wish assumes visible, practical form, and is carried out; and in your solid, slow—necessarily slow, because you do not get much engineering for sixpence—solid, slow, yet stable and enduring way, you are straightening the crooked path for the rest of mankind to follow in every town and city in this country. Beyond that the rougher elementary duties of sanitation depend upon you. You are always combating dirt, disease and death in the interest, I am glad to say, of an increasingly sober and educated democracy, and in so far as you deserve thanks from the ratepayer, on his behalf this morning I cheerfully accord it. You come to London and to Battersea to hold your meeting. May I say as a Londoner born and bred, that there are many lessons for engineers and surveyors to learn from the city of London. One says that, as I do, after a long visit, with the eye of an engineer and a sanitary reformer, through America and Canada last autumn. Every engineer and surveyor, whencesoever he comes to London, must see in London's bridges, its tunnels, its drainage, and its physical difficulties and conveniences, sufficient to interest him, much to inspire him, and many things to evoke both his scientific and artistic admiration. Canova said it was worth coming from Italy to see an arch of Waterloo Bridge. No one could look at the Tower Bridge and not feel proud of that tremendous structure. No one could look at Blackwall Tunnel completed, and the larger Rotherhithe Tunnel in construction, without having object lessons of solid, useful engineering triumphs for the health and convenience of this large city. Now London has not ideal physical conditions to help either the medical officer or the engineer, but I am glad to say that, thanks to the ratepayers' generosity, the engineers' skill, and the medical officers' devotion in the last fitfy years, London has overcome the many difficulties in the way much quicker, and much easier for public convenience, than many cities not half so large have attempted, and if attempted have not done so well. We recently have had in this country of ours a wave of self-depreciation passing over us. It has lasted for about ten years. You could not take up a news-

paper or a magazine, but you had Paris idolised, Berlin idealised, and were told to go to America, to Vienna, and to other places, where we should find our municipal guides, philosophers, and friends. I do not share that depreciation, or identify myself with that criticism. On the contrary, I say with the pride of a Londoner, with all its size, taking into consideration its great age, the density of its population, the physical and other difficulties, I know of no other city in the world, where the triumphs of the engineer, the surveyor, and the architect are so conspicuous, when you consider the difficulties to be encountered in this large metropolis of ours. Considering that it was built by instalments without definite plan, London is to me the most interesting, as, I believe, everyone who is truthful will admit, the most fascinating gathering of mankind that was ever seen. I am pleased to say that under the influence of county council engineers, local surveyors, improvement committees, both county council and borough council, it is consciously making up its mind to deliberately shape, fashion, and remodel its life upon a better plan than that we inherited. You, gentlemen, can see that, in the extraordinary street improvements that have taken place in the last eighteen years. People who talk and depreciate London life forget its magnitude. Who among the journalists in a hurry, who attack and too often deride London, realise that in the last eighteen years there have been 500 street and road widening improvements carried out. I venture to say that no other city can show the same rapid strides; and what is more, I venture to say, if we can keep up the rate of progress of the last eighteen years, and satisfy the ratepayer—as the intelligent ratepayer has already been satisfied—London in a few years, apart from being the most interesting and fascinating city will begin to be, as I want it to be, the most beautiful city in Europe. I have reason to say this, because for eighteen years I have been a main drainage commissioner of the county of London. Where is there a city whose local drainage is so good and its main drainage so excellent as the city in whose walls you meet to-day? Its sanitation is rapidly and disproportionately improving. I venture to say that no other city in the world has shown the progress in sanitary improvements that we have. The test of this is the low death rate, which is the result of your efforts and the expenditure through your hands of the ratepayers' money. We are told to go to Paris, to Berlin, to

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Vienna, to Marseilles, and to Lyons, and see what they are doing. Those cities may be more beautiful from the æsthetic aspect, more beautiful to the eye, but in many of them you are confronted with all-pervading smells, which come up from the earth, or down from the air like a shop-shutter falling upon you out of its place. That is not so in London. The dust is better collected than it was. Thanks in a large measure to Sir George Livesey and his gas stove, and the incoming of the electric light, it is not so smoky as it used to be. What other city in the world can boast of 500 underground lavatories, which were the invention and creation of English surveyors, and which other cities with leaden feet are trying to imitate. When you consider the enormous extent of London's drainage—a river of sewage 11 ft. wide, 8 ft. deep, flowing at the rate of 4 ft. per second—there is a difficulty which the London County Council's engineers manage with singular economy. I have only one other word to say—as to what we are indebted to you for. It was a medical axiom in the time of Sir Benjamin Richardson that the death rate of the community kept pace with its population. You engineers and sanitarians are beginning to prove that statement was not true. On the contrary we witness in Battersea, thanks to Mr. Pilditch, our late worthy and excellent surveyor, and Mr. Hayward, his worthy successor, and our late medical officer, Dr. McCleary, and his successor, Dr. Kempster, its untruth. In 1869, 1870, and 1871, with only 54,000 people, Battersea had a death rate of 26 per thousand. In 35 years the population has grown from 54,000 to 175,000, or more than three times, and yet the death rate in that period has dropped from 26 to 14 per thousand, as it is at this moment. That, gentlemen, is better than a monument in Portland stone or granite to all of you. What is more, infantile mortality has dropped, in ten years only, from 176 per thousand to 131 per thousand. You will this afternoon go through the small artisans' estate, known as the Latchmere estate. That was carried out by Mr. Pilditch, constructed by the Works Department, and built by Battersea workmen. You will find on that estate the death rate is even lower than that I have quoted. The general death rate is as low as 11 per thousand—almost equal to Brighton or Bournemouth—and the infantile mortality 77 per thousand, or 20 per thousand lower than in the servant-keeping class in the West End of London. What is true of Battersea,

is true of London, and also, in a similar way of other towns. My last point or two—you must remember that you are the *corpus vile* on which I have more or less to experimentalise for the benefit of a wider audience—is this, and it is in your defence: whenever a road is to some critics a pit for the burial of the engineer or surveyor, and wherever there is a construction for the health or the convenience of the community, letters of protest begin to pour in. As a practical man, and one who wants to move about easily and quickly, I sometimes think that by co-ordinated effort on the part of everybody in London, we could diminish the number of street openings that take place. But it is not quite so easy as the professional critic thinks, and if you diminish them in number, you will have to spend a larger amount of money than is now spent by providing a means by which the openings in future will be diminished. People also say when the roads are slippery, "Where is the surveyor?" and they look suggestively at the nearest lamp-post, and when they hear the rattle of the council cart, they think it is the tumbril carrying the surveyor to his execution. There are 2160 miles of streets and roads in London. That means a tremendous task in these days of bicycles, motor-cars, and of heavy traffic. These 2160 miles of streets and roads require a deal of ingenuity and patience, both on the part of the surveyors and their staffs. The cost of these 2160 miles of streets and roads is 2,200,000*l.*, and the average cost ranges from 5300*l.* to about 1000*l.* per mile. When you think those roads have to bear the wear of the continually moving iron-shod hoofs of 500,000 horses driven by 120,000 carmen, it is an army in itself—you must realise the enormous traffic, as compared with Continental cities, to which the London streets and roads are subjected; and when people talk about the Boulevards of Paris, Berlin, Vienna, and Budapest, they all forget that the heavy traffic which pounds away the streets is infinitesimal, even microscopic, as compared with the heavy traffic through the streets of London, which is still the largest industrial and manufacturing city in the world. I would ask the indignant critic, the uninformed critic, to remember that no officers managing any city in the world have anything like the trouble and difficulty that the London engineers and surveyors have in maintaining the roads and streets of London. I have one other word to say. London does not make a practice of doing what Paris and

Berlin do. If you go to Paris and Berlin, you will see fifteen to twenty roads regularly cleansed and in the pink of condition; but go down the side streets, and you will find an entirely different state of things. I say the uniform excellence of the poor streets of London compares favourably with any city in the world. What is more, their average upkeep and their freedom from noxious dirt and nuisance is superior to any city in the world. If you want a proof of that simple statement, it consists in the fact that, notwithstanding the large number of people living in London, and the density of its population, and, in too many cases, the preventable poverty of many of its citizens, the fact that it is the healthiest city in the world is proof of what I have said. It is your business to further improve it; it is the ratepayer's melancholy duty to provide you with the means; and, in proportion as he grumbles, so must he be prepared to rectify. After all, is it not worth improving? London has got a variety no other city could show. It has still left much picturesqueness. But it has still got a good deal of the cheap and nasty about it. As a public man, in my opinion—and you see it perhaps better than I do—London has got too many squalid, ugly, cheap, and nasty shops; too many ugly advertisements on flank walls, obtruding themselves everywhere. The vulgarity of cheap advertisements is conspicuous, and increasingly so. And what is more, the streets of London are too often occupied by obstructions which impede traffic, destroy the decent appearance of the streets, and add to the litter and the avoidable dirt that is conspicuous in our public thoroughfares. We have got rid of the foul and noxious nuisances which used to be in London streets twenty-five to thirty years ago. What is the pest of London streets to-day? It is the trade litter, it is the shop refuse, it is the flying newspaper placard, it is the refuse from barrows, and the refuse from shops; and the daily litter, in itself not particularly offensive or insanitary, is particularly repugnant to the eye of one who has a love of the tidy street. What is more, there is no need for it. The borough councils are rapidly abolishing the system of making the shopkeepers pay for the removal of trade refuse. Now the councils are removing trade refuse without payment at all, the cheesemonger and the egg-seller should not take the opportunity when no one is looking of jerking that which we ought to save for election times under the passing tramcar or the fleeting horses' feet. We have no

right to have our streets the repository of election eggs, rotten bananas, and decaying tomatoes, and I hope the day is not far distant when we shall see a conference of borough surveyors, with the Chief Commissioner of Police, the officers of the London County Council, and representatives of the shopkeepers and the costermongers, all making up their minds to co-operate together to prevent the untidy refuse and litter in the streets of London being continued, and, what is more, taking drastic steps to bring its abolition about as early as possible. I know such a conference will be difficult to arrange, but I do not mind, as an impartial person, taking the chair. And I would even go further and suggest that where the borough councils do not provide large bins, the railway companies might provide large bins in the yards of railway stations, into which cabdrivers and busmen and newspaper boys could put their litter, instead of putting it down in the streets, as they do now, to the indignation of every surveyor in the neighbourhood of large railway stations. I think the time has arrived when a person like myself should tell the public if they were as energetic for street tidiness as they are in blaming the surveyors for not bringing it about, it would be astonishing what an improvement would take place in the streets of London. You can see well-dressed men walking along the street throw away a newspaper, and though I can understand some men wanting to get rid of some newspapers, no man has a right to take a four-, six-, or eight-page paper open and extended, and because he has done with it throw it away on the side-walk, and be a positive danger to any young and restive horse under whose nose the wind blows it. I believe if the ordinary foot passenger were to select the gutter for the discarded paper, and roll it up before he cast it down, it would add enormously to the tidiness and appearance of the streets of London. The untidiness of the individual citizen is often attributed to the neglect of the surveyor and his staff, and I sincerely trust, if the newspaper men do not report anything else, they will report my suggestion to my fellow-citizens on how to make London litter less conspicuous than it is. I have only one word to add, and it is for the children. The surveyors have a kindly place in their hearts for the children who make the streets their playground and recreation place. Might I suggest that you might imitate Battersea in one respect, and it is this. The medical officer and surveyor have co-operated recently in urging that the

back yards of small houses in mean street should no longer have what is called mould-paving but what is only an excuse for the aggregation of dirt. Wherever you can persuade landlords to tar macadam the back yard, you are doing it for the children, and to prevent disease. I hope and believe all you do will be inspired by one objective—that is the interest of the commonwealth. I believe you do always bear in mind the improvement of the streets that come under your charge, and the proper discharge of the multifarious duties which modern progress is imposing upon you. In the performance of those arduous duties you must often feel depressed, because you are often heart-broken by senseless criticism and foolish grumbling; often your ideas are restrained by niggardly committees and parsimonious councils. I ask you not to lose faith in the greatness of your profession, in your sanitary aims and municipal ideals. If the average ratepayer would only rise to the level of the ordinary engineer, through whose hands this money is spent and invested for the good health of the community, and would obtain much of your practical good sense and ideals, then we could have in the next generation an average death-rate of not more than 10 or 12 per thousand everywhere, and we ought to bring down the infantile mortality in poor streets from 200 and 250 to 100. All that is needed is money, and if that money is granted, your profession will endeavour to give value to the ratepayers, and you will add to the comforts, pleasure, and well-being of the ratepayers whose guides, philosophers, and friends you are.

The PRESIDENT: I desire, sir, on behalf of the Association, to thank you very heartily for the kind way in which you have received us. We shall always look on this as a record meeting. It is only the second time we have been honoured by the presence of the President of the Local Government Board, and it is the first time we have listened to such an address as we have had to-day.

I feel that in Mr. Burns we have a champion. Ever since the Association was formed, we have felt that in many ways we have not been fairly treated by the powers that be. I know Mr. Burns is a busy man, but I feel sure he will receive a deputation from our Association, and if we have any grievances, he will put them right.

ENGINEERING NOTES ON THE PUBLIC WORKS OF A METROPOLITAN BOROUGH—BATTERSEA.

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It is proposed to deal with the several matters contained in these notes under the following headings :—

1. Historical.
2. Statistical.
3. Industries.
4. Roads and streets.
5. Footpaths.
6. Private streets.
7. Parks and open spaces.
8. Scavenging.
9. Depots.
10. Refuse destruction and disposal.
11. Artificial flag making.
12. Public lighting.
13. Sewers and sewers cleansing.
14. Combined drainage.
15. Bridges.
16. Tramways (electrification of existing lines).
17. Water supply.
18. Town hall and municipal buildings.
19. Libraries.
20. Electricity works.
21. Stables, Lombard Road.
22. Baths, Latchmere Road, including new ladies' swimming bath.
23. Baths, Battersea Park Road.
24. Artisans' dwellings at Latchmere Estate.
25. Artisans' dwellings at Town Hall Estate.
26. Proposed housing scheme, Battersea Park Road.
27. Museum and baths, Plough Road.
28. Public laundry and laundry for disinfecting station at baths, Latchmere Road.
29. Public mortuary and coroner's court.
30. Disinfecting station.
31. Temporary shelter, Sheepcote Lane.
32. Public conveniences.
33. Works department.

Other undertakings owned by the Council, but not specially dealt with, are—

(1) Cemeteries. (*a*) Battersea Rise, 8 acres, now closed for all but existing graves; (*b*) Morden, 123½ acres.

(2) Infant's milk depot for the supply of sterilised milk. Average of 400 infants supplied daily.

1. Historical.

Battersea is in many respects a most interesting district of the Metropolis. Originally a marsh-covered area swamped by the river Thames at times of flood or high water, it has now, owing to the energy and enterprise of the several governing bodies who have from time to time had control of its municipal affairs, become one of the most healthy boroughs in London.

From an historical point of view Battersea does not lack interest, as there are records of its existence as far back as the time of King Harold. Most of the early history has been preserved in the form of Royal Charters granted by successive sovereigns. For a long period it was held by the Abbot of Westminster, who secured it from King William I. in return for the redemption of the crown jewels, which had been pawned previous to his invasion.

Apparently the value of Battersea was not considered to be very great in those days, as from the Doomsday Book it is found to be recorded at 80*l.* With the coming of the Conqueror, however, it decreased to 30*l.*, but pending the Doomsday Survey it again rose to about its original value, the actual amount being 75*l.* 9*s.* 8*d.*

The area at that time was considerably more than at present, as it comprised the hamlet of Penge and other outlying areas, including Wandsworth, Peckham, and part of Lambeth, Camberwell, Streatham, and Tooting.

No other district has suffered more than Battersea from what may be termed "land grabbing," as at the time the Charter was held by the Abbot of Westminster it comprised 6906 acres, but in after years much of it was encroached upon by persons whose title would seem to have been somewhat dubious.

About the time of the Conqueror, Battersea appears to have become attached to the "Hundred of Brixton," and this apparently is the first record that can be found of municipal government in the borough.

2. Statistical.

The borough is 2307 acres in area, and for electoral purposes is divided into nine wards. The population is estimated at 200,000, and the rateable value is 1,163,119*l.* The rate for the current half year is 4*s.* 2*d.* in the £, which includes the County Council rate, Police rate, Education rate, Metropolitan Asylums Board rate, Poor rate, and the General District rate, the last-mentioned being only equal to 1*s.* 5*d.* in the £. The borough is situated on the south side of the river Thames, and has a frontage to the river of 3¼ miles.

The health of the district is exceptionally good, as the death rate for the year ending December 1905 was only 14·4 per thousand, as against 17·2 per thousand for the Metropolis.

3. Industries.

Battersea has been described in the past (and that description holds good to-day) as a "hive of industry," and, from the following list of works and factories in its midst, it will readily be seen how aptly this name can be applied.

The principal works and factories are as follows:—

London & South-Western Railway Works; South-Eastern & Chatham Railway Works; Gas, Light & Coke Company's Gas-Works; Messrs. Price's Patent Candle Company; Messrs. Garton Hill & Company's Saccharum Works; Messrs. Morgan's Crucible Company's Plumbago Works; The Projectile Company; and some thirty other large manufactories.

4. Roads and Streets.

The total number of streets in Battersea is 461, while the length when last recorded was approximately 80 miles. The widest street is 80 ft., and the narrowest 20 ft., but more than 90 per cent. of the whole are 40 ft. wide. These are more or less busy thoroughfares, and are paved approximately as follows:—

Granite setts	3 miles.
Hard wood blocks	4¼ „
Soft wood blocks	1 mile.
Blue bricks, with wood pegs inserted (McDougall's patent)	$\frac{1}{10}$ „
Tarred slag macadam	5¼ miles.
Ordinary granite macadam	21 „
Flint macadam	45 „

The proportion of ordinary macadam unfortunately ranks rather high, but the Council now recognise the advisability of paving the streets with more durable and economical material.

The average cost of constructing roads with the above-named materials in Battersea at the present time is as follows:—

	Per Superficial Yard.
Granite setts, 5 in. by 4 in., specially dressed, exclusive of foundations	10s. 6d.
Hard wood blocks (Karri), ditto	13s. 6d.
Soft wood blocks, ditto	9s.
Blue bricks, with wood pegs inserted, McDougall's patent, ditto	10s. 6d.
Tarred slag macadam, including preparation of foundations	from 3s. to 4s. 6d. according to thickness.
Ordinary granite macadam	1s. 8d.
Flint macadam	1s.

The Author would like to direct the attention of the Members particularly to the specially dressed granite setts now being used in Falcon Road. The setts are carefully squared and gauged to height, and in consequence a true and even surface is obtained, with narrow joints, which considerably reduce the noise, and lessen the tractive effort. The setts are 5 in. in width by 4 in. in depth, and the covering capacity, being large, more than counterbalances the increased cost of dressing necessitated by the squaring.

Reference may also be made to the patent "acme-sectional" hard wood blocks, which are now being laid in Battersea Park Road, and which have already been used with considerable success in several metropolitan boroughs. The blocks in question are made 9 in. long, 3 in. wide, and 3 in. deep, built up of small pieces from 1 in. to 2 in. in thickness, the sections being fastened together by fillets let into grooves on the underside of the blocks. By using the timber in these small scantlings, it is found that more thoroughly seasoned wood is obtained than is the case with the 3-in. by 9-in., or 3-in. by 6-in. planks. Timber of small dimensions, as in the "acme-sectional" block will season better in twelve months than the larger sizes would in from four to six years. The great difficulty which has been experienced in the past with regard to hard wood block paving has been the excessive shrinkage and swelling which take place at the various changes in the weather conditions; and in order to reduce these as much as possible, the Author has

used, and is using, in extensive paving works being carried out in the borough, in connection with the electrification of the tramways (referred to more particularly hereafter), blocks only 6 in. in length; and it is anticipated that this will greatly lessen the inevitable movement caused by contraction and expansion.

It is believed that the sectional blocks before referred to will still further decrease the shrinkage, and probably in the discussion which follows this paper, Members who have used these blocks will speak as to their action. The samples of this paving which the Author has seen laid have been most satisfactory.

Battersea has adopted tarred slag macadam to a considerable extent, with a view to obtaining a more impervious paving. The results obtained after two years' wear have been most satisfactory, both in streets used mainly for vehicular traffic and also in some of the by-streets, which are largely used as playgrounds by the children. In the latter case it has been much appreciated, and medical evidence is strongly of opinion that it conduces to the better health of the inhabitants. Altogether about 5½ miles of streets have been paved with this material, several of which are main thoroughfares subjected to omnibus and other heavy traffic. In adopting this material for road-making, the principal point to bear in mind is that the slag must be of the best quality. All honeycombed or otherwise defective material must be rejected. The mixing with tar should also be scientifically carried out, so as to ensure the right amount of tar only being used. This is essential, as if too much is used the road will not consolidate, and will only bring discredit upon all concerned. On the other hand, if too little tar is used, the surface becomes dry, and will readily break up. Subject to the material being properly selected and mixed in the right proportions, there is no doubt, in the Author's opinion, that it will prove to be one of the best substitutes for ordinary macadam on our public highways. The cost works out very favourably in London as compared with Guernsey granite, or similar material.

In side streets where the traffic is only light, 3 in. or 3½ in. of material is ample, and can be laid at a cost of 3*s.* to 3*s.* 6*d.* per superficial yard, whereas on the more busy thoroughfares where the traffic is heavy and concentrated, the thickness should be not less than 3½ in. to 4½ in. when rolled, in which case the cost would be from 3*s.* 6*d.* to 4*s.* 6*d.* per superficial yard.

5. Footpaths.

The footpaths in the borough, with the exception of those in main streets, had been allowed, during the existence of the late vestry, to get into very bad condition. They were mostly paved with tar-paving made from the clinker refuse obtained from the destructor, and it was not until the year 1902 that the Borough Council took the matter seriously in hand. It was then decided to expend a sum of 50,000*l.* spread over a period of five years, or about 10,000*l.* per annum, provided a loan could be obtained for the work, and this scheme is now being carried out.

In Battersea, as in other boroughs, the havoc played with the carriageways and footways by the incessant openings for gas, water, electric light, telegraph, telephone, and other purposes has to be continually borne in mind, and to give some idea as to what this means, it may be mentioned that no less than 4241 openings were made in the streets of Battersea during the year ending March 1905. All the reinstatements are carried out by the Council's workmen at the following schedule charges.

		After April 1905. s.	d.
York paving (relaid)	at per yard super.	2	3
„ „ (new 2½ in. laid)	„	11	9
„ „ (flushed)	„	4	0
Artificial paving (relaid)	„	2	3
„ „ (new 2½ in. laid)	„	8	0
Wood paving (relaid)	„	2	6
„ „ (new 9-in. by 5-in. by 3-in. blocks, laid and grouted)	„	15	0
Tar paving (improved)	„	4	0
Pitching (relaid)	„	2	6
Cubes (new 4-in. by 4-in. by 4-in.)	„	12	0
Pitching (new 4-in. by 7 in.)	each	0	9
Tee scoria setts, new (laid)	„	0	6
Blue bricks (relaid)	at per yard super.	2	0
„ new (laid)	each	0	5
Tile paving on forecourts (relaid)	at per yard super.	3	0
Cement paving on forecourts	„	2	0
Granite macadam	„	2	6
Flint macadam	„	1	6
Lime concrete	at per yard cube	14	0
Cement concrete	„	18	0
Kerb (reset on lime concrete)	at per foot run	0	6
„ new (set on lime concrete)	„	2	6
Cutting round boxes (large)	each	3	0
„ „ (medium)	„	2	0
„ „ (small)	„	1	6
Tarred slag	at per yard super.	9	0

—	Gas Light and Coke Company.	South Metropolitan Gas Company.	Metropolitan Water Board.		Wandsworth and Putney Gas Company.	Post Office Telegraphs.	Electricity Department.	Miscellaneous.	Total.
			S. and V. District.	Lambeth District.					
Number of trenches	1371	1020	1415	113	32	140	135	15	4241
Area of flagged footways ..	545 yds.	661 yds.	443 yds.	43 yds.	26 yds.	1716 yds.	431 yds.	867 yds.	4782 yds.
" new flagging	64 "	53 "	40 "	3 "	..	166 "	30 "	36 "	392 "
" tar-paved footways	1040 "	1653 "	361 "	96 "	24 "	485 "	173 "	170 "	4002 "
" other footways ..	..	..	..	..	..	18 "	2 "	..	20 "
" roadways, macadam	2670 "	714 "	1042 "	145 "	39 "	68 "	128 "	22 "	4828 "
" wood-paved roadways.	16 "	14 "	96 "	..	..	22 "	6 "	..	154 "
" tarred slag macadam roadways.	14 "	3 "	32 "	5 "	22 "	..	..	..	76 "
" pitching and channel	474 "	182 "	366 "	18 "	4 "	131 "	24 "	..	1199 "
" other roadway ..	..	..	..	..	..	15 "	..	..	15 "
" length of kerb ..	154 ft.	47 ft.	46 ft.	..	..	14 ft.	46 ft.	..	307 ft.
Amount of re-instatement charges	632*l*. 2*s*. 3*d*.	523*l*. 10*s*.	314*l*. 15*s*. 9*d*.	44*l*. 18*s*. 3*d*.	21*l*. 18*s*. 6*d*.	381*l*. 4*s*. 0*d*.	112*l*. 6*s*. 6*d*.	147*l*. 9*s*. 3*d*.	2178*l*. 5*s*. 3*d*.

Total area of footways disturbed	.. ..	9,009 super. yards.
" carriageways disturbed	.. ..	6,244 "
		15,343

6. Private Streets.

Practically the whole of the land in Battersea available for building purposes is now built over. It is only when any of the few remaining old houses with large grounds come into the market that new streets are laid out. In such cases, the usual practice is for the owner of the estate to lay out the streets, and construct the sewer and surface water gullies, under the supervision of the borough engineer. Upon completion of building operations, the roads are made up and taken over by the Borough Council under order of apportionment, the estimated cost being first deposited by the owners of the property.

The specification for the formation of the road usually adopted is 12 in. of hardcore with 4 in. of metalling, 12 in. by 8 in. dressed kerb laid on 6 in. of cement concrete, 14 in. channels, composed of dressed granite setts also set on concrete, and 2½ in. York paving for the footpaths. The minimum width allowed for new streets is 40 ft., the footpaths being each 8 ft., and the carriageway 24 ft.

The cost per foot of frontage for a 40 ft. street is as follows:—

12 in. of hardcore, 4 in. tarred slag macadam, channels, kerbs and York paving all as above, including the adjustment and renewal of gullies where necessary	22*s*.
The like with granite macadam	20*s*.
The like with flint macadam	18*s*. 6*d*.

Batttersea has been alive to the importance of wide thoroughfares, and during the past twenty-five years a sum of about 100,000*l*. has been expended in street and bridge improvement works. This does not include the improvements carried out in conjunction with the London County Council, and to which that body has contributed. The cost of the latter improvements has amounted to an additional sum of 135,000*l*.

7. Parks and Open Spaces.

Battersea is well supplied with parks and open spaces, which no doubt partly account for the very low death rate before referred to. The chief of these is Battersea Park, abutting upon the river Thames and comprising some 200 acres. It is laid out partly as a recreation ground and partly as an artificial lake for boating.

Wandsworth and Clapham Commons, 200 acres of which are in Battersea, have also been greatly improved during recent years, accommodation being provided for cricket, football, etc., as in Battersea Park.

In addition to these, the Borough Council maintain a recreation ground at Christ Church Gardens, also a small recreation ground in Vicarage Road, formed partly by reclaiming waste land from the foreshore of the river Thames, and partly in connection with an important street widening in that district. At the present time the Council are laying out a recreation ground on the northern portion of their housing estate in the Latchmere district. This work is being done partly by help received from the Central (Unemployed) Body of London and partly by loan. Trees have been planted in the streets of Battersea to the number of 2170.

8. Scavenging.

For the purpose of street cleansing, the borough is divided into five districts, each in charge of a separate road inspector working under the direction of the highways superintendent, who in turn is responsible to the borough engineer. Each inspector has an average of thirty-eight men, including the caretakers at depots, the men in charge of the wharves, messengers, etc. No men are employed on the highways under the age of forty years, the average age of the men at the present time being fifty-four years.

All the wood and impervious pavements are washed not less than three times a week, except during frosty weather. The mud taken from the streets (and it can be readily understood that this is no small quantity owing to the large proportion of ordinary macadam roads) is disposed of principally by barge,

although a small quantity is sent away by rail during the dry weather. Unfortunately the Council have been unable to obtain a shoot within the district, the nearest one being about two miles distant from the southern portion of the borough. A large amount of mud or slop arises from the macadam roads, and it is somewhat difficult at times to know how to cope with it, as a sufficient number of barges cannot always be obtained. The cost of disposing of the refuse after being placed in the barge is 2*s.* 10*d.* per load, and in consequence it is a difficult matter to keep the cost of scavenging at a low figure. Hence the advantage of impervious pavements.

It may be of interest to the Members to know that, from observations the Author has made, the amount of slop derived from tarred macadam roads is considerably less than half the amount taken from ordinary macadam roads.

Experiments have been tried with regard to placing individual men in charge of small districts, but as this interferes very considerably with the quick cleansing of the main roads it has not been largely adopted.

The men of the highways cleansing staff also carry out the whole of the repairs to the macadamised roads, including the tarred slag macadam. Two (nominally) 10-ton steam rollers, with a scarifier, and also a 6-ton roller are kept continually in use upon the work.

9. Depots.

The Council have always felt the want of one central depot, but owing to the excessive price of land this could not be obtained, and recourse has had to be made to obtaining it as and when occasion arose.

The result has been that the Council own more than fourteen depots in various parts of the borough, some of which will be described, and the purpose for which they are used referred to, later in the paper. The remainder are allotted to the work of the highways for the storage of material to be used for repair purposes, for the housing of carts, vans, tools, plant, disinfectants, and all incidental appliances, and as depots from which the men start work.

10. REFUSE DESTRUCTION AND DISPOSAL DEPOT, CULVERT ROAD.

At the present time 60,000 tons of house and trade refuse are being collected in Battersea per annum. Of this about one-third, which includes garbage and trade refuse, is burnt in the destructor, the remaining two-thirds being sent away by barge. The destructor, which is of an early type, was erected some twenty years ago by Messrs. Manlove, Alliott & Co., of Nottingham, and is without forced draught. The destructor consists of twelve cells constructed back to back, with one common flue midway between the two rows of cells, and, although it is now out of date, it has done good work in the past. The Council have the question of the erection of an up-to-date destructor now under consideration.

The price per ton for barging away refuse under the present contract is less than the cost of burning, and were it not for the insanitary method of dealing with the refuse in sending it away into other districts, and also the uncertainty as to the price for future disposal, it would, perhaps, be advisable to adhere to this method.

The question of how often the refuse should be collected is a very wide one. In Battersea endeavour has been made to meet the wishes of the whole community, and in some cases the collection is made daily, except Sundays, in some three times, and in others once a week, according to requirements. It has been found that, where a general collection has been made more often than once a week, the occupants of the houses will not trouble to open the doors to let the dustmen through, and in the past a considerable amount of time and money has been lost in this way. The house scavenging arrangements are directed by the superintendent of highways, who is also the dusting manager. The work is arranged in districts, nine gangs being employed, each consisting of six men and four single-horsed vans. It is usual to commence on the outskirts of the borough, working towards the destructor and the wharves, the men having regular rounds; and each gang is expected to collect between 30 to 40 cubic yards per day, which would work out at appproximately 1*s*. 3*d*. per cubic yard for collection. Many of the houses have small forecourts or front gardens, and the occupiers usually put the

bins out ready, when it is quickly picked up, shot into the van, the bins sprinkled with carbolic powder and returned to their standing places. In the case of the bin not being placed outside the men go through the house, fetch, and return the bin, but in no case do they go either upstairs or down. Of course, if the bins were placed outside in all cases, it would very much lessen the cost of collection.

11. Artificial Flag Making.

A large quantity of artificial paving has been made by the works department from destructor clinker. This was at first made by hand in moulds, but the result was not satisfactory owing to the fact that the clinker from the destructor was not of the best, and that consequently a large amount of moisture was absorbed. The Council in 1904 purchased and erected one of Messrs. Musker's (Liverpool) three-mould hydraulic flag-making machines, and have since made the stones by machinery. The press is provided with three sets of moulds and dies to make slabs, 3 ft. by 2 ft., 2 ft. by 2 ft. 6 in., and 2 ft. by 2 ft. The machine works at a pressure of 2000 lb. to the square inch, and exerts a pressure of 500 tons on the slabs. The pumps, which are of the three-throw belt-driven type, are fed from a tank to which the waste water returns, and consequently only a small supply is required to provide for leakages. No accumulator is used, the water being pumped direct into the cylinder. The total cost of the plant was about 1800*l*. Since its erection the machine has been in constant use, and at times worked by two shifts of men; at present, a ganger and thirteen men are engaged in working the machine, and these turn out about 600 yards per week.

The material used for the base of the slabs is composed of crushed clinker from the destructor and Portland cement in the proportion of three to one, about $1\frac{3}{4}$ in. thick, and the face is composed of $\frac{3}{4}$-in. granite grit and Portland cement in equal proportions. Several kinds of granite grit have been tried for this purpose, and experience has decided in favour of Norwegian washed grit not exceeding $\frac{1}{8}$ in. in size.

The cost of making the slabs and stacking complete including all charges is less than 2*s*. per yard. 64,000 yards of machine-made slabs have been made and laid in the borough during the past two or three years.

12. Public Lighting.

The highways are lighted by about 2500 lamps, the main streets by electricity supplied from the Council's electricity works, and the side streets by gas from the respective gas companies. Of the 2500 lights, 259 are electric arc lamps (large size) for which the electricity department charge 18*l.* per annum, and 22 electric arc lamps (small size) for which the charge is 10*l.* per annum. Recently, 213 gas lamps in one part of the borough have been adapted for Nernst electric lamps, the cost of lighting the latter being 6*l.* per annum each.

Of the gas lamps, 926 are incandescent, which the companies light and maintain at a cost of 3*l.* 3*s.* 9*d.* each. The remainder, which the Council anticipate replacing in the near future with electric lamps, are of the flat-flame type, the charge for which is 3*l.* 0*s.* 8*d.* per annum.

13. Sewers and Sewers Cleansing.

There are about 73 miles of local sewers, varying in size from 9-in. stoneware pipes to 3 ft. 9 in. by 2 ft. 6 in. brick sewers, the gradient ranging from 1 in 10 to 1 in 1500. The majority of the brick sewers were constructed from thirty to forty years ago, in many cases very indifferently; these have been gradually overhauled, and all new sewers are now laid on more scientific lines; both pipe and brick sewers are surrounded with 6 in. of Portland cement concrete.

The whole of the sewage of the borough is discharged into the main sewers vested in the London County Council, which traverse the borough in several directions. These intercepting sewers are all constructed of brick, and vary in size from 4 ft. 6 in. by 3 ft. to 9 ft. by 6 ft., with gradients of from 1 in 140 to 1 in 1800, the total length being about 9 miles.

The chief of these is the "low level sewer" passing through York Road, Battersea Park Road, and Nine Elms Lane, which in the past has been the primary cause of the low-lying parts of the borough being flooded on occasions of heavy rains. This sewer (which is only 5 ft. in diameter), receives the sewage also of a large district to the west of Battersea, and on the occasion of storms occurring at a time when the tide in the adjoining

river is high, receives no relief until it reaches the Heathwall pumping station at the eastern end of the borough.

A storm-water relief sewer is now being constructed from South Street Wandsworth to Creek Street Battersea, a distance of 1½ miles, and a new pumping station is to be erected which will raise and discharge the storm water into the river near the latter point. The sewer throughout is 6 ft. in diameter, and is being constructed partly in open cutting and partly in tunnel. The invert is of blue brick, the remainder being of 9 in. gault wire cut bricks surrounded with 6 in. of Portland cement concrete of square section. Where formed in tunnel the brickwork is 1 ft. 1½ in., and has an average of 6 in. of brick packing on the top segment.

In Battersea there is a total length of 3557 ft., of which 1730 ft. are in tunnel and 1827 ft. in open cutting, the depth varying from 18 ft. to 66 ft., with a gradient of 1 in 564. The subsoil in the part of open cutting was gravel, and in the tunnel clay. A large quantity of water was met with in the gravel which necessitated a considerable amount of pumping.

Falcon Pumping Station.—The new relief sewer will discharge into the pumping station, before referred to, which is being erected at Creek Street on the site of one formerly existing, but which was dispensed with several years ago when the Heathwall station was erected.

The new station is 106 ft. long by 51 ft. wide, and the foundations are carried to a depth of 15 ft. below O.D.

The work below ground level consists of a sump-pit, about 28 ft. deep, formed of Portland cement concrete, 7 to 1, through which a 7 ft. diameter sewer is carried with six outlets 2 ft. 3 in. in diameter, to which the pump suction will be fitted. The invert of the sewer is at minus 10·25, and practically forms the pump-well.

This station will receive the storm water from three separate sewers, viz.: the low level sewer in York Road, 4 ft. 7 in. barrel; the Falcon Brook sewer, 4 ft. by 2 ft. 8 in., which runs at the back of the houses in Ingrave Street; and the new 6 ft. barrel sewer forming part of the new relief sewer.

The sewage falling over weirs to an invert level of minus 10·25, will accumulate in the above-mentioned 7 ft. diameter sewer, and will be raised and discharged into the Battersea Creek through an existing outlet at all times of the tide.

The first instalment of three 27 in. centrifugal pumps, (supplied by Messrs. Mather and Platt, Limited), each capable of discharging 13,333 gallons per minute to a height of 16 ft. 6 in., will be driven by three gas engines of the enclosed vertical type, with three inverted cylinders, 17 in. diameter by 20 in. stroke, 175 brake horse-power, at 185 revolutions, the contract for which is placed with the Campbell Gas Engine Company.

In consequence of many of the local sewers having such slight gradients, the expense of cleansing is somewhat heavy. A gang of twelve sewer flushers is continually employed by the Council; the cost of this work last year amounted to 1486*l.*

14. Combined Drainage.

In Battersea there are many instances where originally "premises within the same curtilage" are now premises not in the same curtilage. Let us suppose, for instance, that a large house and garden was many years after its erection divided and made into two or more separate properties. For this purpose no alteration in the drainage was necessary. There are many such cases in the borough, and the mere fact of the property being so divided has resulted in what was originally a drain for which the owner was responsible, becoming a sewer for which the sanitary authority is responsible. The total cost to Battersea during the last nine years of reconstructing drains which have become sewers has amounted to nearly 20,000*l.*, and the liability of maintaining these sewers still continues.

The London County Council have on several occasions endeavoured to obtain Parliamentary powers to deal with this unjust state of affairs, and some time ago Battersea, in conjunction with other Metropolitan Borough Councils, appointed a deputation to wait upon the President of the Local Government Board, but up to the present the desired relief has not been obtained.

15. Bridges.

Battersea is so intersected with railways that it has been necessary to construct a large number of bridges both over and under such railways. These bridges were originally narrow brick arches, which have now nearly all been reconstructed, widened and converted into steel girder bridges. This has in-

variably been accomplished by imposing the condition when the railway companies have promoted Parliamentary Bills for widening their lines, etc. A notable case is the bridge passing over Falcon Road, where originally a brick arch existed. It is now a steel girder bridge of fine proportions, having a span of 40 feet and a width of 260 feet, and carries the main and branch lines of the London and South Western Railway, the London, Brighton, and South Coast Railway, the West London Extension Railway, and one or two smaller lines. This is believed to be the widest bridge, and to carry more trains than any other railway bridge in the country; over 2000 trains daily passing over it. The abutments of all the bridges are lined with white glazed bricks, and the Borough Council keep these clean, receiving an annual payment from the railway companies towards the cost.

The latest railway bridge in Battersea is one constructed over the new subway recently formed to open up a small colony known as the Latchmere Grove Estate. This estate consists of a large number of small houses entirely surrounded by railways, and until this new subway was formed there was only one means of access. The subway consists of a thoroughfare, 350 feet long and 20 feet wide; it is crossed by two steel girder bridges, 36 feet in width; the abutments being, as in all other cases, lined with glazed bricks.

16. Tramways.

The great undertaking of electrifying the tramways south of the Thames by the London County Council was commenced in 1900, and up to date over 40 miles of route have been converted. The Battersea lines were left undisturbed until last year, when negotiations were advanced sufficiently to permit contracts to be concluded for the conversion of the Westminster and Wandsworth tramways. The total extent of lines comprised in this scheme is slightly over 6 route miles, of which considerably more than half are situated in the borough of Battersea.

The route of the lines in Battersea extends from a point in Nine Elms Lane near Wandsworth Road via Battersea Park Road, to a point in York Road near Usk Road, and from Battersea Park Road via Falcon Road to Lavender Hill. For a great portion of the route the original roadway was so narrow that the old horse tramways were constructed very largely of single line

with passing places at more or less infrequent intervals. Very considerable expenditure has been entailed in acquiring and setting back properties and altering pipes in these narrow parts; and when all the widenings are completed, the only piece of single line in Battersea will be a short section of about 60 yards in York Road opposite the Battersea Empire music-hall.

The most difficult portion to deal with in respect of widenings for tramways has been in Nine Elms Lane. A considerable section of this road had a carriageway under 30 ft. in width, whereas when the improvement has been completed the least width will be 33 ft., and this only for a short distance. The operations in effecting this change have involved pulling down and rebuilding various warehouses and other buildings, the setting back of long lengths of boundary walls and shifting a large number of mains from underneath the tramway area to the side of the widened roadway. Prior to the widening the pipes were so numerous in certain parts of this road that if placed side by side they would cover a greater area in width than the surface of the carriageway and footpaths. The alterations have involved dealing with water-mains of 15 in., 20 in. and 30 in. diameter, and gas mains of 24 in. and 36 in. diameter.

In Battersea Park Road and York Road also, the pipe alterations have been very extensive, the principal items being the laying of a new 36-in. water-main on the north side of the roadway. Where the old main lay near the edge of the tramway it was moved into a new position in the road breast, but where it was well underneath the tramway a new main was laid and the old main lifted, while the tramway reconstruction works were proceeding.

In no other part of London have the obstructions been so numerous, and it is expected when the works are completed that over 30,000*l.* will have been expended in removing obstructions for the 6 miles of route.

The tramway construction proper is modelled largely on the original form adopted for the Tooting lines, the principal difference being that yokes with extended arms are used to anchor down the track rails, and that the slot is 1 in. wide instead of $\frac{3}{4}$ in.

The construction of conduit lines has been illustrated so fully in the technical papers that an extensive description is not necessary, but the following brief description may explain

the leading features to those who are not acquainted with this system of tramway construction.

The principal feature is the conduit, placed in the centre of each track, in which are installed two ⊢-shaped conductors for the purpose of supplying current to the car motors. Both conductors are suspended in the conduit from porcelain insulators, fixed to the bottom flange of the rails forming the slot, through which the plough or collector suspended from the car truck hangs for collecting current from the bars. Comparing with the overhead system, one bar takes the place of the overhead wire and the other bar takes the place of the bonded track rails forming the return to the station. In the conduit system the track rails form no part of the electrical circuit, and the polarity of the bars can be reversed, so that any fault appearing can be thrown at a moment's notice on the return bar, where the effect of the fault will be almost negligible.

The line is divided into complete half-mile electrical sections, fed separately by means of cables from the various sub-stations. These cables are drawn through ducts laid for the most part underneath the footpath, and at each break of section a pillar is placed on the footpath with suitable switches and other apparatus for cutting out and otherwise controlling the electrical distribution to the lines. The running or track rails are of British Standard section, weighing 104 lb. per yard, the slot-rails 63 lb. per yard, and the conductor rails 23 lb. per yard. The section of the conductor bar is $2\frac{1}{4}$ sq. in., and the tests show that the soft metal in the bars give a conductivity equal to one-sixth of pure copper.

The drainage of the conduits is fully provided for by large sumps placed at intervals of 40 yards, and all the sump connections are trapped from the sewer.

A solid 9 in. concrete bed has been laid for a foundation to the paving, and the track rails are securely anchored to this concrete bed every 7 ft. 6 in. The paving in the tramway tracks consists for the greater part of 6 in. by 3 in. granite setts. Opposite churches wood paving has been laid.

Concurrently with the tramway reconstruction proper, the breasts of the roadway throughout the whole of the borough of Battersea will be paved with "Karri" hard wood blocks, or special dressed Norwegian granite setts laid on a 9-in. concrete bed.

17. WATER SUPPLY.

It may be very interesting to some to know that the Battersea Borough Council have been enterprising in this respect. It was found that the cost of water for baths and other purposes was so excessive that the Council decided to attempt to obtain a supply of its own.

Four artesian wells were sunk on the site of the Latchmere baths to a depth of about 520 ft., and two of similar depth at Nine Elms baths, and one at the electric generating station.

The boreholes are lined to a depth of 360 ft. with mild steel casing tubes 10 in. in diameter by $\frac{5}{16}$ in. thick screwed at joints and fitted with steel barrel sockets, extending 15 ft. into the chalk, the remaining depth being an open bore-hole 10 in. in diameter to a total depth of 517 ft. Outer protecting tubes 14 in. in diameter and $\frac{1}{4}$ in. thick, are fixed for the first 40 ft. to prevent all surface or impure water from obtaining access to the wells.

The pumping plants consist of artesian well engines having 11 in. steam cylinder and 36 in. stroke, fitted with steam adjustment valves and differential plungers for forcing water on the down stroke, and also copper air chambers and non-return valves.

The rising mains are composed of mild steel tubes lap-welded longitudinally 200 ft. in depth, 7 in. internal diameter by $\frac{1}{4}$ in. thick, screwed at joints.

The pumps are of the deep well lift and force type, the internal diameter of the barrel being $6\frac{3}{4}$ in. and suitable for a working stroke of 36 in.

The suction pipes consist of 20 ft. of steel tubes 6 in. in diameter provided with strainers at the bottom ends.

The pump rods are of pitch pine $3\frac{1}{2}$ in. in diameter joined by means of fishplates and bolts, kept central in the main by hard wood guides. The rods are fitted with forged connections at bottom ends for attaching to pump buckets.

The pumps deliver into tanks, and are capable of lifting 10,000 gallons of water each per hour, so that, if needs be, 60,000 gallons per hour can be pumped.

A tank is provided at each establishment for storage purposes, and in order to more rapidly fill the swimming-baths. These consist of circular steel tanks 40 ft. in diameter and 30 ft. deep, made of Siemens-Martin steel; the bottom plates are $\frac{5}{16}$ in.

thick, the first, second and third tiers of plates $\frac{5}{16}$ in. thick, and the fourth, fifth and sixth tiers $\frac{1}{4}$ inch thick.

An additional high level tank is provided to supply the Latchmere estate, so as to obtain sufficient head to deliver water to the first floor tenements.

The borings were executed and the pumping plant supplied by Messrs. A. C. Potter and Co., of Lant Street, Borough, and have given every satisfaction. The greatest quantity of water pumped in any one day since the wells have been in operation is 400,000 gallons, but considerably more could be obtained, particularly at Nine Elms, where the supply appears most prolific, the level of the water in the boreholes never having been lowered.

The supplies are used for the swimming-baths, slipper-baths, public wash-houses, street watering, and the artisans' dwellings on the Latchmere estate. The cost works out at $\frac{3}{4}d.$ per thousand gallons, but it should be pointed out that steam is already generated on the premises, and only a proportion of this is charged to the pumping account.

Constructional Works—Public Buildings.

18. Town Hall and Municipal Buildings.

These were originally designed by Mr. E. W. Mountford, F.R.I.B.A., and were built by Mr. W. Wallis, the foundation stone being laid on November 15, 1893, by the Right Hon. The Earl of Rosebery, K.G.

The buildings have a frontage of 110 ft. to Lavender Hill and a return frontage to Town Hall Road of 293 ft. The principal entrance to the municipal buildings is from Lavender Hill by means of a semicircular portico, which gives access to a large vestibule at the end of which is the main staircase, giving access to the Council chamber and committee rooms on the first floor.

The Council chamber is situated on the first floor and measures 55 ft. by 35 ft. by 25 ft. in height. The whole of the fittings are in oak, and a panelled dado is carried round the walls, the ceiling being framed in circular panels of fibrous plaster. The grand committee room and members' library are on either side of the Council chamber.

Some years after the buildings were opened it was found that the office accommodation provided for the Town Clerk was insufficient, and, in order to remedy this, plans were prepared by the borough surveyor for an extension, including an additional committee room. This was accomplished by adding another story to the existing offices on the west side of the buildings, the whole of the work being carried out by the Council's works department.

The principal entrance to the Town Hall is in Town Hall Road. The grand hall measures 117 ft. by 56 ft. by 40 ft. high, and provides accommodation for about 1200 people. Underneath the grand hall is the lower hall, capable of accommodating about 400 people.

Other additions made during recent years under the supervision of the borough surveyor include banqueting hall, cloak rooms, retiring rooms, lavatories, etc.

The Council felt that the Town Hall was incomplete without an organ, and the borough surveyor was instructed to prepare plans showing the best means of providing accommodation for an organ, which was erected at a cost of approximately 3,000*l* The necessary structural alterations were carried out and the oak case executed entirely by the works department.

The style of the Town Hall and municipal buildings is Renaissance, and the facings are of red Suffolk brick relieved with Bath stone, the roofs being covered with Westmoreland slates.

The cost of the buildings, including the recent alterations, new organ, etc., totals 45,000*l*.

19. Libraries.

The borough possesses three libraries, the central library, Lavender Hill, in close proximity to the Town Hall, and branches at Lurline Gardens and Lammas Hall, Bridge Road West.

The central library consists of a large news room on the ground floor, 36 ft. by 26 ft., reading room, 32 ft. by 26 ft., and lending library, 58 ft. by 52 ft., to which is attached the librarian's office, 26 ft. by 14 ft.

On the first floor is the reference library, 52 ft. 6 in. by 34 ft., and magazine room, 37 ft. by 30 ft. The remaining portion of

the first floor, together with the rooms above, is occupied by the librarian as his residence.

In the basement are the book store and the necessary store rooms and heating chamber.

Several alterations and extensions have been made from time to time, including an extension of the lending library with caretaker's apartments above, conversion of the book stores on the first and second floor into a magazine room by removing the floor between the two, constructing a gallery round the upper portion with shelving for books and forming lantern light above, also the erection of a children's reading-room on land at the rear.

In all cases the work was carried out by the works department to the design of the borough engineer, the cost of the work amounting to approximately 3000*l.*

Lurline Gardens Branch Library is a one-story building, and consists of a lending library, 37 ft. by 32 ft., magazine room, 35 ft. by 18 ft., reading and newspaper room, 37 ft. by 37 ft., and children's room, 18 ft. by 13 ft.

Lammas Hall Library consists of lending library and news room, 48 ft. 6 in. by 33 ft., and children's room, 24 ft. by 11 ft., in addition to storage accommodation, all of which are on the ground floor.

The caretaker's residence is on the first floor, and the heating apparatus and coal store are in the basement.

20. Electricity Works.

The electricity generating station has an area of about 5300 square yards, of which 2900 square yards are covered by buildings, leaving ample room for future extensions.

The principal elevation is to Lombard Road, from which access is gained to the offices, whilst the entrance for workmen and for the delivery of machinery and plant is by means of a private roadway from Holman Road.

The buildings, consist of offices, engine-room, 90 ft. by 71 ft., boiler house, 123 ft. by 64 ft., coal store, 80 ft. by 64 ft., and battery room, 63 ft. by 20 ft., together with meter testing and arc-lamp room, pump room, and store room for mains department.

The offices on the ground floor comprise a general office,

28 ft. by 13 ft. 6 in., mains office, 14 ft. by 11 ft., and engineer's private office, 22 ft. by 10 ft. 6 in., with waiting-room attached.

Adjoining these is a time-keeper's office, also drivers' and stokers' room, with the necessary lavatory accommodation.

Residences are provided on the first floor for the chief electrical engineer, and also for the assistant electrical engineer.

The chimney shaft, which is a striking feature of the building, is octagonal in plan and measures 25 ft. 6 in. by 25 ft. by 6 in. at the base, and 13 ft. 6 in. by 13 ft. 6 in. at the top. It rises to a height of 195 feet above the ground line, the foundation being about 30 feet below the street level. The concrete upon which it rests is 10 ft. thick and 36 ft. 6 in. square.

For the year ending 1905, the plant installed was as follows:—

Two 46 k.w., two 192 k.w., and one 324 k.w. Willans, Mather and Platt engines; one 350 k.w. turbine generator; two 750 k.w. turbine generators, making a total of 2742 k.w. or an equivalent of not less than 3700 i.h.p. A further extension of an 850 k.w. set by Bellis, Mather and Platt, is being installed during this year, and the present engine room will allow for a further extension of a similar size. At the end of the present year the plant installed will have a total capacity of 3592 k.w. or over 4800 i.h.p., and when the present building has all the plant installed, the total capacity will be equal to some 4500 k.w. or 6000 i.h.p.

The boiler house, which is 123 ft. long by 64 ft. wide, at present contains a battery of nine boilers, of Babcock and Wilcox make, each of a nominal steaming capacity of 11,000 lb. of steam per hour, or when pressed 14,000 lb. Eight of these boilers are fitted with mechanical stokers and one is hand-fired, the whole battery working at a pressure of 200 lb. per sq. in. The coal bunkers are built above the boiler house wherein coal can be stored to an amount of some 800 tons, it being delivered by conveyor from a dock at Grove Wharf. The feed water for the boilers is obtained from an artesian well and delivered to a storage tank above the building, whence it is pumped to the boilers, through economisers, by means of weir pumps having a total capacity of 19,000 gallons per hour.

The system of condensing is that known as the ejector type. The water for this purpose is obtained from the Thames, and to

do this a pump house is erected on the banks of the river wherein are installed three electrical centrifugal pumps, two having a capacity each of 100,000 gallons per hour and one a capacity of 270,000 gallons per hour.

The maximum load registered on the station during 1905 was 1515 k.w., and at the present moment over 30 miles of mains are laid.

The whole of the work of erection of buildings, etc., was carried out by the Council's works department under the direction of the borough engineer at a cost of approximately 55,000*l*.

21. Stables, Lombard Road.

These buildings have a frontage to Lombard Road of 135 ft., and a return frontage to Falcon Wharf of 146 ft.

The buildings are three stories in height and are built in three blocks. On the ground floor there are forty-seven stalls, 6 ft. wide, four loose boxes, three harness rooms, horsekeeper's office, farrier's shop, and the necessary conveniences for the men.

An inclined roadway leads from the rear portion of the stable yard to the gallery on the first floor, which is carried by wrought iron cantilevers and brackets.

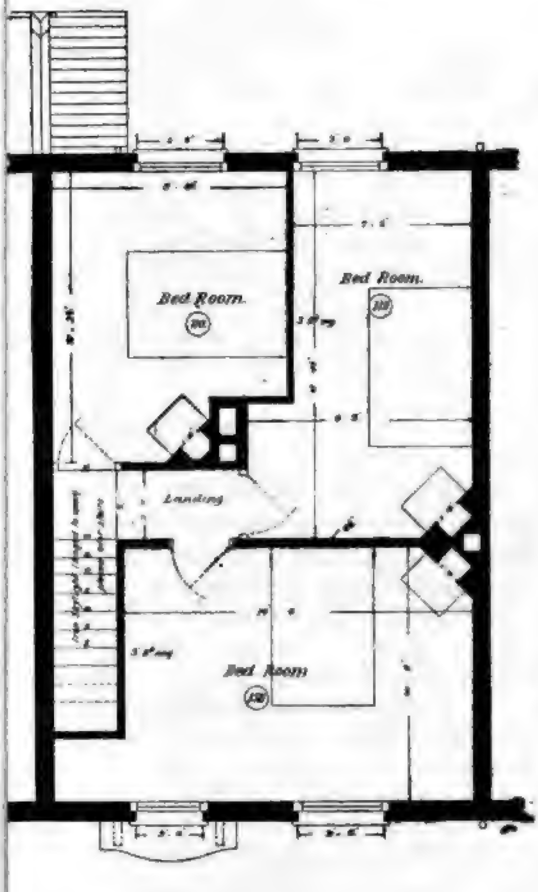
The first floor contains forty-nine stalls, 6 ft. wide, four loose boxes, and three harness rooms, whilst the whole of the second floor is used as a storage room for fodder, and the necessary tanks for storage of water. This floor also contains chaff-cutting machines and food-preparing apparatus with shoots leading to the ground and first floors for the conveyance of the fodder, etc. There are in addition electrically driven friction hoists for raising fodder, etc., from the ground floor level to the second floor.

The whole of the work was carried out by the Council's own works department at a total cost of 17,500*l*.

22. Latchmere Road Baths.

The Latchmere Road Baths contain three swimming-baths, with a full complement of slipper-baths, viz.: first-class, 100 ft. by 35 ft.; second-class, 97 ft. by 30 ft.; boys, 75 ft. by 25 ft.; and seventy-two slipper-baths. Eleven men's first-class slipper-baths; fifty-two men's second-class slipper-baths; three women's first-class slipper-baths; eleven women's second-class slipper-baths.

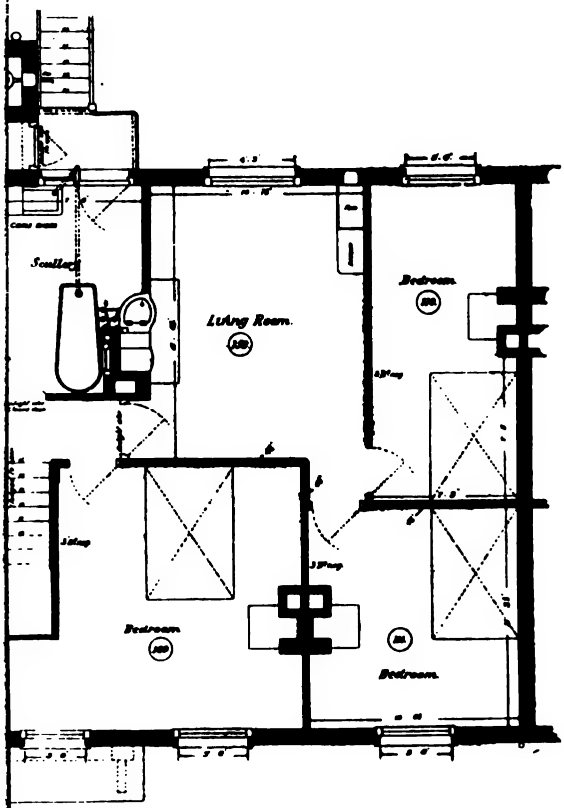
PLATE I.



IL ARTISANS' DWELLINGS.

[Face p. 244.

PLATE II.



the first floor, together with the rooms above, is occupied by the librarian as his residence.

In the basement are the book store and the necessary store rooms and heating chamber.

Several alterations and extensions have been made from time to time, including an extension of the lending library with caretaker's apartments above, conversion of the book stores on the first and second floor into a magazine room by removing the floor between the two, constructing a gallery round the upper portion with shelving for books and forming lantern light above, also the erection of a children's reading-room on land at the rear.

In all cases the work was carried out by the works department to the design of the borough engineer, the cost of the work amounting to approximately 3000*l*.

Lurline Gardens Branch Library is a one-story building, and consists of a lending library, 37 ft. by 32 ft., magazine room, 35 ft. by 18 ft., reading and newspaper room, 37 ft. by 37 ft., and children's room, 18 ft. by 13 ft.

Lammas Hall Library consists of lending library and news room, 48 ft. 6 in. by 33 ft., and children's room, 24 ft. by 11 ft., in addition to storage accommodation, all of which are on the ground floor.

The caretaker's residence is on the first floor, and the heating apparatus and coal store are in the basement.

20. Electricity Works.

The electricity generating station has an area of about 5300 square yards, of which 2900 square yards are covered by buildings, leaving ample room for future extensions.

The principal elevation is to Lombard Road, from which access is gained to the offices, whilst the entrance for workmen and for the delivery of machinery and plant is by means of a private roadway from Holman Road.

The buildings, consist of offices, engine-room, 90 ft. by 71 ft., boiler house, 123 ft. by 64 ft., coal store, 80 ft. by 64 ft., and battery room, 63 ft. by 20 ft., together with meter testing and arc-lamp room, pump room, and store room for mains department.

The offices on the ground floor comprise a general office,

28 ft. by 13 ft. 6 in., mains office, 14 ft. by 11 ft., and engineer's private office, 22 ft. by 10 ft. 6 in., with waiting-room attached.

Adjoining these is a time-keeper's office, also drivers' and stokers' room, with the necessary lavatory accommodation.

Residences are provided on the first floor for the chief electrical engineer, and also for the assistant electrical engineer.

The chimney shaft, which is a striking feature of the building, is octagonal in plan and measures 25 ft. 6 in. by 25 ft. by 6 in. at the base, and 13 ft. 6 in. by 13 ft. 6 in. at the top. It rises to a height of 195 feet above the ground line, the foundation being about 30 feet below the street level. The concrete upon which it rests is 10 ft. thick and 36 ft. 6 in. square.

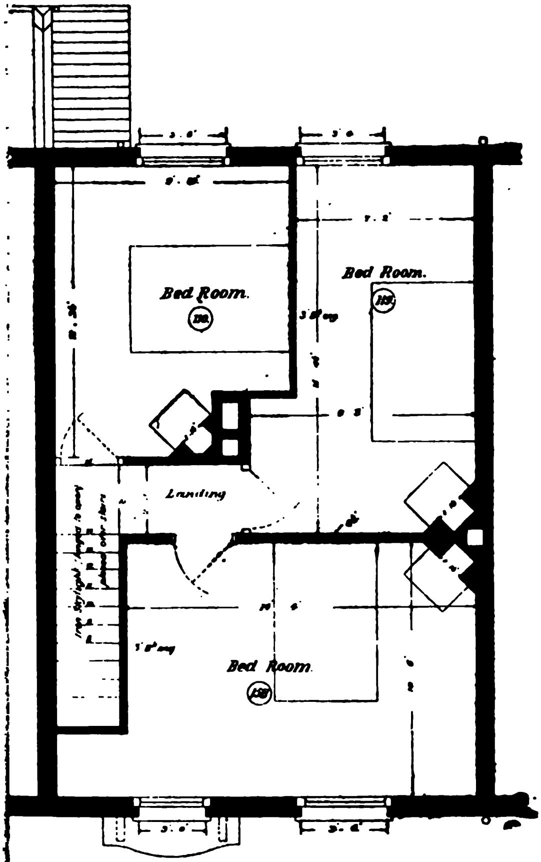
For the year ending 1905, the plant installed was as follows:—

Two 46 k.w., two 192 k.w., and one 324 k.w. Willans, Mather and Platt engines; one 350 k.w. turbine generator; two 750 k.w. turbine generators, making a total of 2742 k.w. or an equivalent of not less than 3700 i.h.p. A further extension of an 850 k.w. set by Bellis, Mather and Platt, is being installed during this year, and the present engine room will allow for a further extension of a similar size. At the end of the present year the plant installed will have a total capacity of 3592 k.w. or over 4800 i.h.p., and when the present building has all the plant installed, the total capacity will be equal to some 4500 k.w. or 6000 i.h.p.

The boiler house, which is 123 ft. long by 64 ft. wide, at present contains a battery of nine boilers, of Babcock and Wilcox make, each of a nominal steaming capacity of 11,000 lb. of steam per hour, or when pressed 14,000 lb. Eight of these boilers are fitted with mechanical stokers and one is hand-fired, the whole battery working at a pressure of 200 lb. per sq. in. The coal bunkers are built above the boiler house wherein coal can be stored to an amount of some 800 tons, it being delivered by conveyor from a dock at Grove Wharf. The feed water for the boilers is obtained from an artesian well and delivered to a storage tank above the building, whence it is pumped to the boilers, through economisers, by means of weir pumps having a total capacity of 19,000 gallons per hour.

The system of condensing is that known as the ejector type. The water for this purpose is obtained from the Thames, and to

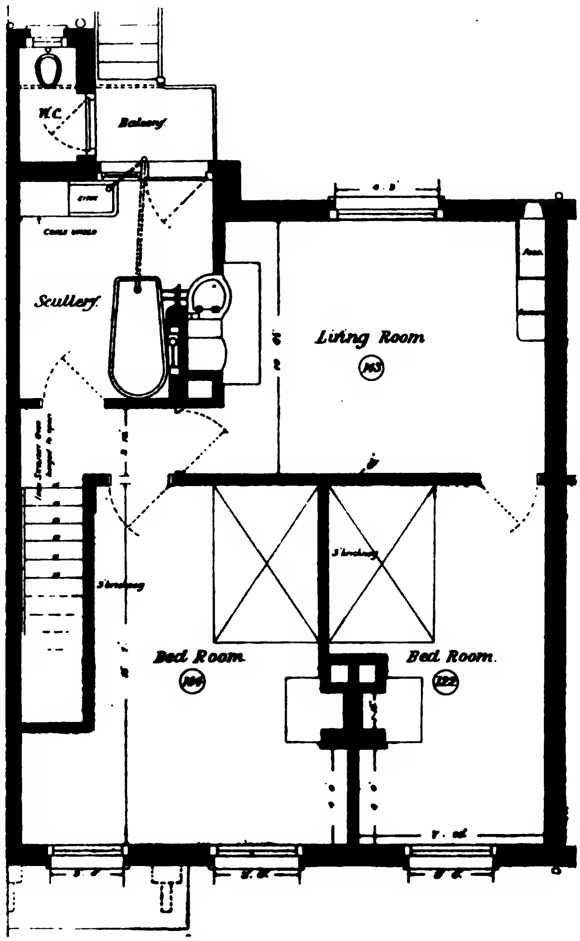
PLATE I.



IL ARTISANS' DWELLINGS.

[*Face p.* 244.

PLATE IV.

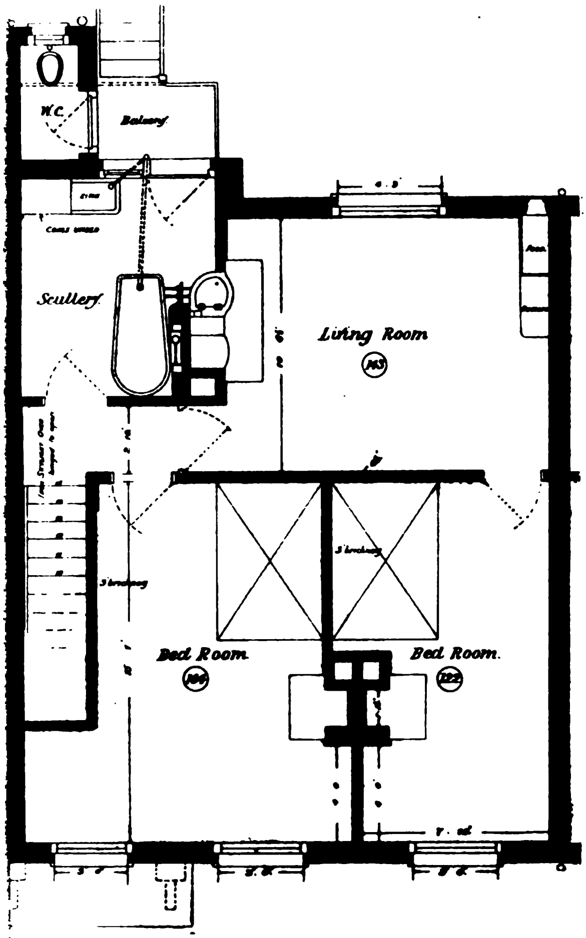


W.C.
Balcony
Scullery
Living Room
143
Bed Room
104
Bed Room
122

PLATE V.

DWELLINGS · Theatre St

PLATE IV.



W.C.
Balcony
Sink
Coals under
Scullery
Living Room
143
Bed Room
106
Bed Room
122

PLATE V.

DWELLINGS · Theatre St.

PLATE VI.

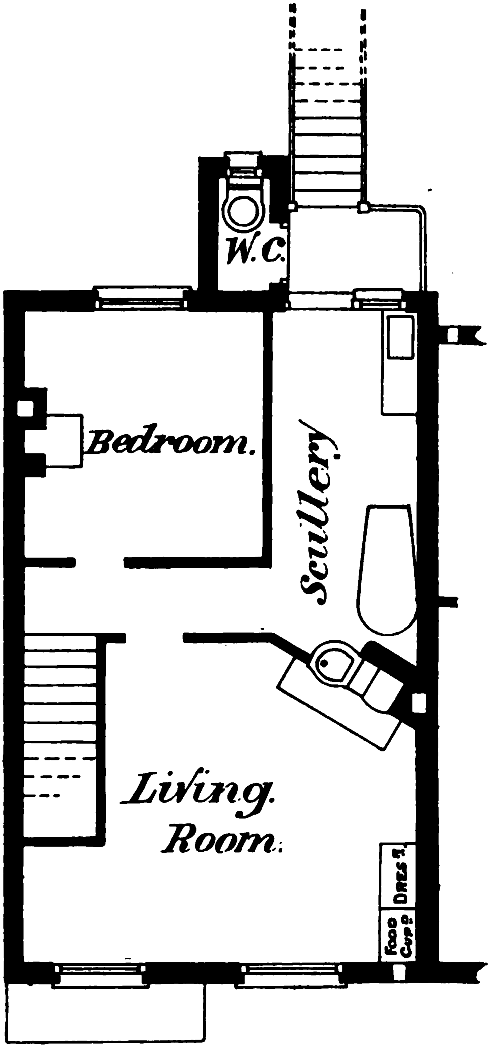
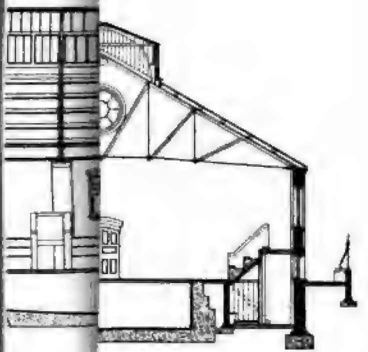
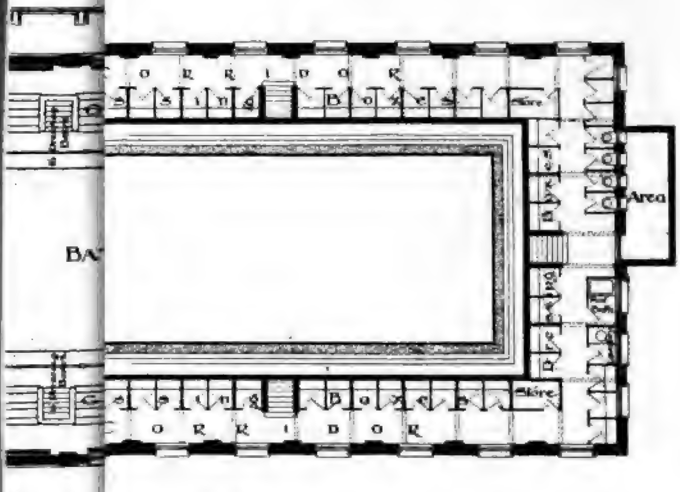


PLATE VII.



RSE SECTION.



EL DER GALLERY.

In addition to the above, there is a residence and office for the superintendent; a committee room, 25 ft. 6 in. by 16 ft.; and a hall or club room, 43 ft. by 29 ft.

The first and second class swimming-baths are boarded over during the winter months and used as a gymnasium and recreation room respectively. The former is fitted up with all necessary appliances for gymnastic purposes, and the latter with billiard and bagatelle tables and other games; a charge of 1*d.* is made for admission.

Ladies' Swimming-Baths, Burns Road.

These buildings adjoin the existing Latchmere Road Baths, and have a frontage to Burns Road of about 140 ft. They comprise swimming-bath, waiting-hall, dressing-room, six first-class, and three second-class slipper-baths.

The bath is designed in the amphitheatre style, the sides being formed into tiers to admit of a large number of spectators being able to witness swimming contests. The swimming-pond is 76 ft. by 25 ft., the depth of water at the shallow end is 2 ft. 10 in., and at the deep end 6 ft., the bath being calculated to hold 52,000 gallons of water.

The side walls and bottom of the pond are constructed in cement concrete, and are faced throughout with white glazed bricks, an asphalt lining being laid between the concrete and the bricks.

The bottom of the pond is relieved with green glazed bricks formed into bands, panels and stars of ornamental design, which form guiding lines when swimming contests are held.

The height of the building to the eaves is 15 ft., the roof being supported by eight steel trusses, 52 ft. span with circular ribs supporting the lantern light, the top part of which is covered with patent glazing, and the sides hung with sashes arranged to open.

There are three tiers of seats on each side of the bath, and under these are situated the dressing-boxes (fifty-six in number), access being gained thereto by means of five flights of York stone stairs leading from the sides of the bath.

The seating accommodation is of fireproof construction, the joists and stanchions carrying same being of steel filled in with cement concrete, the seats being of teak.

The divisions and doors to the dressing-boxes and also those to the slipper-baths are constructed in teak, and the slipper-baths are of enamelled fire-clay.

The whole of the work including the ornamental wrought-iron gates and railings, and the steel roof trusses, was carried out by the works department at a cost of 8100*l*.

23. Baths and Wash-Houses, Battersea Park Road.

These buildings are in the Renaissance style of architecture plainly treated, and have a frontage to Battersea Park Road of 137 feet, and a depth to Cringle Street of 266 feet.

They comprise the following departments:

Swimming-bath; six men's first-class slipper-baths; thirty-two men's second-class slipper-baths; three women's first-class slipper-baths; nine women's second-class slipper-baths; public wash-houses and ironing-room; establishment laundry; boiler-house and engine-room.

The swimming-bath is 150 ft. long and 50 ft. wide clear water space, this being the largest covered swimming-bath in England. The depth of water at the shallow end is 3 ft. 6 in. and at the deep end 6 ft. 6 in., the baths holding 200,000 gallons of water.

The walls of the pond are constructed of cement concrete lined with asphalt, the sides being faced with white glazed bricks and the bottom with white and blue glazed flat bricks forming an ornamental pattern.

A gallery is formed on three sides of the bath supported by cantilevers, and the roof is constructed with circular ribbed steel trusses of ornamental design resting upon riveted stanchions built into the walls, the whole terminating in a large lantern light.

The slipper-baths are fitted up with enamelled and marbled slate divisions, hot and cold supplies, the baths being of enamelled iron.

The public wash-house is 71 ft. by 25 ft., and consists of fifty-three washing compartments, each containing two troughs, one for boiling and one for rinsing, hot, cold and steam services being laid on. To each washing compartment is attached one drying horse, with additional horses for the washing machines. There are also four hydro-extractors for drying the clothes.

The ironing room is 50 ft. by 16 ft., and adjoins the wash-

house; it contains four mangles and ample ironing and folding tables. The room is lighted and ventilated by means of lantern lights running the full length, the floors being laid with wood blocks.

The establishment laundry is on the first floor, the towels and other articles being conveyed there from the official corridor on the ground floor by means of a lift.

The water for the swimming-bath is heated to the required temperature partly by the exhaust steam from the engine and by means of a specially designed super-heater, and by passing through a jet condenser, which raises the water to the required temperature. The temperature of the water is maintained by circulation, and is drawn from the further end of the bath pond opposite the inlet by a steam ejector, and forced back to the jet condenser, where it is again injected with steam as it passes into the pond.

The water for supplying the slipper-baths and laundry is also heated by passing through the super-heater and the calorifiers, which are supplied in duplicate, and consist of steel cylinders containing copper tubes which are charged by steam at high pressure. In addition to supplying hot water the calorifiers heat the various radiators and pipes which warm portions of the buildings.

The steam for heating the calorifiers, warming the bath pond, boiling the water in the boiling tanks of the public laundry, and working the two engines, is obtained from two Galloway boilers, each 30 ft. long and 7 ft. in diameter, set on the circular draught system.

The buildings are erected with stock bricks, with red brick facings, relieved with Portland stone dressings, the whole of the work having been carried out by the Council's works department at a cost of 45,000*l.*

The swimming-bath is covered over in the winter, and the buildings are used for public meetings, dances, concerts, etc.

24. Artisans' Dwellings, Latchmere Estate.

The Latchmere Estate originally formed part of what was then known as the "Latchmoor" Common, and was enclosed for allotments in 1835, by the churchwardens and overseers, under the provisions of 1 and 2 William IV., cap. 42 (1831).

The allotments were let to persons annually, the rents

(amounting to about 16*l.* per annum) being paid into the funds of the poor rate.

In 1890 the Board of Overseers asked the London County Council to make a provision in their General Powers Bill enabling the board to erect artisans' dwellings on the land, and on November 8, 1899, the County Council acceded to the board's request.

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Plans, specifications, and estimates for two- and three-story dwellings of various types were submitted from time to time by the borough engineer for the development of the estate. Subsequently competitive designs were invited by advertisement, and premiums offered for the best sets of designs submitted.

The borough engineer was then instructed to prepare revised plans based upon the first premiated designs, but omitting certain details which did not meet with the approval of the committee, and inserting a combined bath-room and scullery.

Detailed plans, specifications, and estimates were accordingly prepared, and the work of erection proceeded with by the works department.

There are upon the estate 138 three-roomed tenements, 146 four-roomed tenements, 28 five-roomed houses, 1 four-roomed house, and 1 three-roomed house, providing in all accommodation for 314 families.

The four-roomed tenements are, for the most part, situated in Sheepcote Lane, Burns Road, Matthews Street, west side, Reform Street, and Freedom Street, east side, whilst the three-roomed tenements are in Joubert Street, Odger Street, and Freedom Street, west side.

The five-roomed houses are situated chiefly in Matthews Street, east side, and at the end of the rows in Joubert Street, Odger Street, and Reform Street.

The plans show the arrangement of the several types of dwellings.

The four-roomed tenements in the cross streets have a frontage of 26 ft. 9 in. and a depth of 28 ft. 9 in. The living-room measures 13 ft. 8½ in. by 11 ft., bath-room scullery 10 ft. 5 in. by 6 ft. 3 in., front bedrooms 13 ft. 2 in. by 9 ft. 1½ in.,

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The four-roomed tenements in Sheepcote Lane, 17 in number have a frontage of 29 ft. 1 in., so that the rooms are considerably larger than those in the side streets.

The houses containing three-roomed tenements have a frontage of 22 ft. 6 in., and a depth of 27 ft. 6 in. The living room measures 10 ft. 6½ in. by 13 ft. 4 in., bath-room scullery 8 ft. 10 in. by 7 ft. 3 in., and each bedroom 15 ft. 1 in. by 7 ft. 10 in.

The five-roomed houses have a frontage of 18 ft., and a depth of 27 ft. 9 in. The living-room measures 15 ft. 4½ in. by 10 ft., bath-room scullery 12 ft. 1 in. by 6 ft. 6 in., parlour or bedroom 10 ft. 11 in. by 10 ft. 6 in., front bedroom 14 ft. 4 in. by 10 ft. 6 in., back bedrooms 15 ft. 4½ in. by 8 ft. and 12 ft. 2½ in. by 9 ft. 10 in.

The height of all rooms is 8 ft. 9 in. in the clear.

The whole of the tenements and houses are fitted with kitchener, copper, bath, and sink, and the tenements on the first floor are provided with teak staircases, giving access to the back gardens.

An interesting feature in the living room and scullery bath-room is the "Model Cottager" combined kitchen range, copper, and bath arrangements, which were manufactured and installed by Ellkay and Cornes, Limited.

The apparatus has been designed to secure the maximum of convenience as regards cooking, heating, and washing with the exclusive use of a hot or cold bath at a minimum cost of fuel. It is fixed in the dividing wall between the living room and the scullery bath-room. The heating and cooking part is fixed in the kitchen, the grate (open and close) being in the centre with an oven on one side, and a boiler (which is accessible at the back) on the other. The boiler has a hinged lid and there is therefore no risk of explosion; it has a capacity of 12 gallons of water, 10 gallons of which can be run off, the remainder being held in reserve. By manipulating a damper, the flames are diverted from the range to the copper, to heat the water to wash the clothes, or provide hot water for a bath which is adjacent to the copper in the scullery-bath room. The fuel thus performs a manifold service, thereby effecting considerable economy to the tenant. Should the range fire not be in use at

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any time, a secondary grate, which consumes a small amount of fuel, is provided under the copper. A distinct advantage is that heat is radiated from the back part of the apparatus, and the two rooms are thus kept at practically an even temperature, so that bathing may be indulged in with comfort in the cold weather.

Each tenement has its own separate entrance and back-garden and the whole of the floors are fire-proof throughout, being constructed of coke breeze, cement concrete, and steel joists.

The houses are provided with electric light fittings, and electrical energy is supplied on the penny-in-the-slot system.

The roads and streets also on the estate are lighted by electricity.

The paving of the estate, granolithic sills, heads, cantilevers, lintels, breeze partitions, etc., were made on the ground by the Council's own workmen.

The rents of the various houses and tenements are as follows:—Five-roomed houses 11*s.* 6*d.* per week, four four-roomed tenements to Sheepcote Lane 10*s.* 6*d.*, other four-roomed tenements 10*s.* per week, three-roomed tenements 7*s.* 6*d.* per week, which works out at 2*s.* 6*d.* per room, exclusive of bath-room scullery.

The area of the land occupied by streets and buildings is 7 acres, 3 roods, 2½ poles; the remainder, 3 acres, 3 roods 35 poles, being unbuilt upon, but it is hoped that before long a portion of this will be available for the erection of three-roomed tenements, the remaining portion being left as a recreation ground which is now being laid out.

The estate (although the buildings were not all completed at the time) was formally opened by the Right Hon. John Burns, M.P., who stated that, in his opinion, by building this colony, Battersea had contributed more to meet the alleged decadence of physique than all the articles that had ever been written in the newspapers, and the result of their scheme was a tribute to the unity of Parliament with other bodies.

25. Artisans' Dwellings, Town Hall Estate.

The scheme on the Latchmere Estate proving so successful, the Council, having regard to the great necessity which existed for further working-class houses in Battersea (915 applications in addition to those accommodated having been received at that

stanchions and supporting a lantern light in the centre, the side windows of hich will be made to open for ventilation.

In addition, the whole of the windows in the gables, which are of wrought-iron, will have their upper portions made to open.

The internal portion of the roof will be lined with tongued and grooved boarding covered with inodorous felt and slating.

The floor will be laid with granolithic.

The total estimated cost of the scheme, which is being carried out by the Council's works department, is about 9100*l.*, which includes machinery.

29. Public Mortuary and Coroner's Court.

These buildings are situated in Sheepcote Lane, and have a frontage of 55 ft. and a depth of 87 ft.

On the ground floor adjoining the public entrance is the attendant's room, 15 ft. 6 in. by 14 ft., at the back of which is a shell store, 15 ft. 6 in. by 8 ft. 3 in.

To the left of the main entrance is an arched gateway giving access to the yard in the rear, around which are grouped the following :—

Post-mortem room, 28 ft. 6 in. by 24 ft. 6 in.; mortuary (non-infectious), 24 ft. 6 in. by 18 ft. 6 in.; mortuary (infectious), 17 ft. 6 in. by 12 ft.; doctor's cloak room, w.c. and lavatory; store fordisinfectants.

To the right of the archway is the doctor's retiring room, 12 ft. by 10 ft., whilst to the left is the coroner's room, 14 ft. 3 in. by 10 ft., with a private entrance from Sheepcote Lane, and a lavatory and w.c.

Between the infectious and non-infectious mortuaries is a viewing lobby with large plate glass windows for viewing bodies, and a large cupboard with glass panels for the storage of clothing for bodies unidentified.

From the back of the coroner's room is a private staircase which leads to the coroner's court, a spacious and lofty room on the first floor, measuring 37 ft. by 23 ft.

Adjoining the court and in close proximity to the staircase is the witnesses' waiting-room, 23 ft. by 15 ft. 6 in.

The non-infectious mortuary is fitted up with twenty-eight

bath; the rents charged are 6s. 6d. per week for two-roomed tenements, and 8s. 6d. per week for three-roomed tenements.

The plans for the work were prepared by the borough engineer, and the work carried out by the Council's works department.

The estimated cost of the two estates, including the purchase of additional property, and the construction of roads, sewers, buildings, etc., amounted to 127,424l. A considerable saving was effected on this estimate, the capital expenditure being 114,185l., which amount included 5 per cent. for establishment charges.

The actual cost of building per room, exclusive of bath-room scullery, is 74l., but if the bath-room scullery, which has a superficial area of 75 ft. is counted as a room, the cost would be 65l. per room. The price per foot cube of the building works out at slightly over 7d.

The two estates will be self supporting, and as the loan is paid off, and a consequent reduction in the interest, a substantial income will be derived.

The deficit on the first year's working can hardly be considered as a loss, as it was owing to a portion of the estate not being completed and occupied for the whole twelve months.

The following statement will show the financial aspect of the two schemes:—

	Year ending March		
	1905	1906	1907 (estimated)
Expenditure:—	£	£	£
Salary of superintendent	91	91	91
Rates and taxes	1467	1662	1736
Light and fuel for offices	5	10	10
Telephone, stationery, etc.	25	30	30
Water, Town Hall estate	—	20	20
„ Latchmere estate	60	60	60
Electric light	433	450	500
Repairs and maintenance	370	270	540 *
Repayment, and interest on loans	5338	5841	5664
Cost of loans	12	—	—
	7801	8434	8651
Income:—			
Rents	7224	8050	8100
Electric light	448	507	560
Miscellaneous	12	10	10
	£7684	£8567	£8670
	£117 (deficit)	£133 (balance)	£19 (balance)

* The item for repairs and maintenance has been increased for the year 1907.

26. Proposed Housing Scheme, Battersea Park Road.

By instructions of the Housing Committee of the Council, the Author has prepared a further scheme with plans and estimates for the utilisation, for housing purposes, of the land in Battersea Park Road, Nine Elms, belonging to the Metropolitan Water Board.

An approximate estimate of the whole, including land, roads and streets, retaining walls, filling, etc., is 500,000*l*.

27. Museum and Baths, Plough Road.

The entrance to the museum is from Plough Road, a spacious vestibule leading to the staircase up to the first floor on which is the museum, 42 ft. by 28 ft., children's recreation room, 25 ft. by 16 ft., and store room and office for curator, 13 ft. by 12 ft. 6 in., with lavatory attached.

The entrance to the men's and women's baths is at the side in Benham Street, a pay-office separating the entrances.

There will be eleven slipper-baths for the men and nine for the women, and attached to these will be the necessary waiting-rooms.

The men's entrance also leads to the men's recreation room, 36 ft. by 32 ft., and gymnasium, 35 ft. by 30 ft.

The gymnasium will be fitted up with the necessary apparatus for the equipment of an up-to-date gymnasium, and the recreation room will contain a movable bar for the supply of refreshments, also a billiard table and two bagatelle tables, and several small tables for the playing of such games as chess and draughts.

In the basement is the heating chamber and coal store.

The buildings are fireproof throughout, the floors being constructed with steel joists filled in between with breeze concrete. The floors of the recreation room, gymnasium, museum and children's room are laid with 1½-in. deal blocks laid on concrete, whilst the entrances and corridors to museum and baths are paved with encaustic tiles, the floor of the baths themselves being laid with Euboeolith.

All the rooms are well ventilated, fresh air being admitted by means of inlet panels, and also through ventilating radiators, while the vitiated air is extracted by means of exhaust fans electrically driven.

The rooms will be heated and hot water supplied by means of two independent dome-top boilers fixed in the basement, in connection with which will be a large circulating cylinder.

The style of the building is modern Renaissance.

The whole of the work has been carried out by the Council's works department, at an estimated cost of about 8000*l.*, exclusive of furnishing.

28. Public Laundry and Laundry for Disinfecting Station.

These laundries, which are in course of erection, are being built at the rear of the Latchmere Road baths, and adjoining the disinfecting station. The length of the building is 91 ft., the width 73 ft., and the height 30 ft.

The two, whilst forming one whole building for the sake of economy, are entirely cut off from each other, the entrance to the public laundry being from Burns Road and Matthews Street, whilst that for the disinfecting station is from Sheepcote Lane.

The laundry for the latter is for the purpose of cleansing and washing the linen received from infected houses after disinfecting, before returning the same to the owners. It will be fitted up with steeping-tank, washing machines, hydro-extractor, drying-horses, and mangling machine.

The public laundry will be fitted up with 62 separate washing compartments, each having a cast-iron washing-trough and shelf, with drying-horse near at hand.

There will also be four hydro-extractors and eight mangling machines, all of which will be driven by electricity.

The drying-horses are all contained in a chamber which is supplied with hot air by means of a steam air-heater and large fans driven by electric motors.

The walls of the buildings are being built with hard stock bricks, with red facing bricks to the plinths, pilasters and quoins to the windows and pilasters, the whole of the sills and steps being of York stone.

The interior will be lined with white glazed bricks, with salt-glazed dado to a height of 6 ft.

The roof will be carried by framed steel trusses resting upon

stanchions and supporting a lantern light in the centre, the side windows of hich will be made to open for ventilation.

In addition, the whole of the windows in the gables, which are of wrought-iron, will have their upper portions made to open.

The internal portion of the roof will be lined with tongued and grooved boarding covered with inodorous felt and slating.

The floor will be laid with granolithic.

The total estimated cost of the scheme, which is being carried out by the Council's works department, is about 9100*l*., which includes machinery.

29. Public Mortuary and Coroner's Court.

These buildings are situated in Sheepcote Lane, and have a frontage of 55 ft. and a depth of 87 ft.

On the ground floor adjoining the public entrance is the attendant's room, 15 ft. 6 in. by 14 ft., at the back of which is a shell store, 15 ft. 6 in. by 8 ft. 3 in.

To the left of the main entrance is an arched gateway giving access to the yard in the rear, around which are grouped the following :—

Post-mortem room, 28 ft. 6 in. by 24 ft. 6 in.; mortuary (non-infectious), 24 ft. 6 in. by 18 ft. 6 in.; mortuary (infectious), 17 ft. 6 in. by 12 ft.; doctor's cloak room, w.c. and lavatory; store fordisinfectants.

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From the back of the coroner's room is a private staircase which leads to the coroner's court, a spacious and lofty room on the first floor, measuring 37 ft. by 23 ft.

Adjoining the court and in close proximity to the staircase is the witnesses' waiting-room, 23 ft. by 15 ft. 6 in.

The non-infectious mortuary is fitted up with twenty-eight

catacombs, constructed in wrought iron, the infectious mortuary containing eight, the upper portion of same being covered with charcoal. There is also a galvanized iron shell with glass panel for inspection of decomposed bodies, also small trolley with adjustable top for the removal of bodies.

The post-mortem room is fitted up with lavatory, with hot water geyser, also the necessary sinks, slate slabs and revolving tables for post-mortem examinations.

The rooms are lighted throughout by electricity, and the coroner's court is fitted up with gas piping as a stand-by.

The total cost of the buildings was 4800*l.* (exclusive of furnishing), the whole of the work being carried out by the Council's works department.

30. Disinfecting Station.

The disinfecting station adjoins the mortuary and coroner's court, and has a frontage of 30 ft.

At the front of the buildings is a large van shed with open roof through which is entered the infected chamber, 26 ft. by 16 ft. and 13 ft. 6 in. to eaves, which is fitted up with steeping tanks, etc.

Adjoining the van-shed is the formalin chamber and store room.

At the rear is the disinfected chamber, 26 ft. by 21 ft., and 13 ft. 6 in. to the eaves, fitted with two disinfectors with vertical boiler and cistern. There is a store room at the side of this chamber fitted with shelving and racks for the storage of linen about to be despatched.

Both the infected and disinfected chambers are fitted up with lavatory, bath, and w.c., also extensive cupboard accommodation is provided.

The whole of the buildings were erected by the Council's works department at a cost of approximately 2500*l.*

31. Temporary Shelter, Sheepcote Lane.

The Public Health (London) Act, 1891 (section 60, sub-section 4), imposes an obligation upon sanitary authorities to provide accommodation for persons who have been compelled to leave their dwellings on account of disinfection being carried on therein.

The buildings were erected in 1904, and adjoin the mortuary and coroner's court.

They have a frontage of 40 ft. and an average depth of 25 ft.

On the ground floor is a three-roomed tenement, at present occupied by the mortuary-keeper, and a two-roomed tenement, each having separate entrances. Whilst on the first floor are a two and three-roomed tenement.

All the tenements have bath-room, scullery with sink, etc,, and the living rooms are fitted up with Messrs. Ellkay and Cornes' patent combined kitchen range, copper, and bath arrangements.

The whole of the work was carried out by the Council's works department at a cost of about 900*l.* and the cost of furnishing was about 50*l.*

32. Public Conveniences or Châlets.

There are seven public conveniences in various parts of the borough, only one of which is built underground.

This is at the junction of Falcon Road and Lavender Hill, and contains conveniences both for men and women as follows:—

Men's Department.—Eleven-stalled urinal, three w.c.'s, and two lavatories.

Women's Department.—Two w.c.'s, and two lavatories. Attendants and store-rooms are provided to each.

The walls are of brickwork in cement backed up with cement concrete, and lined throughout with white glazed bricks.

The conveniences at York Road, Bridge Road, and Queen's Circus, Battersea Park, are all of the same design, and provide similar accommodation.

In the men's conveniences are an eight-stalled urinal, four w.c.'s and two lavatory basins, whilst in the women's portion are four w.c.'s and two lavatory basins. In addition there is a small room for the attendants, and store rooms.

The buildings, which are of picturesque appearance, are in the half-timbered style, the lower portion up to the plinth, which is of Portland stone, being built of brickwork, the portion above being framed in timbers filled between with cement rendering and pebble dash face, the roofs being covered with red Brosely tiles, and the floors paved with red quarries on 6 in. of cement concrete.

The two conveniences at Battersea Park (Chelsea Bridge end) are similar in design to the last named.

The men's convenience consists of a seven-stalled urinal four w.c.'s, and two lavatory-basins, whilst that for the women provides four w.c.'s and two lavatories, etc. In addition there is a small room for the attendants, and store-rooms.

The convenience at Christ Church Gardens is for men and women.

In the men's portion are an eight-stalled urinal, four w.c.'s, and two lavatories, whilst in the women's portion are three w.c.'s and lavatory.

The whole of this work, with the exception of Falcon Road châlet, was carried out by the Council's works department at a total cost of about 7500*l.*

33. Works Department.

Any description of the municipal works of Battersea would be incomplete without some reference to the works department, which has grown from a small beginning to a big organisation, with frequently as many as 850 men at work in the various trades (exclusive of the men employed in all the other departments).

Battersea from the first days of its independence undertook the work of scavenging and watering by the direct employment of labour. As time went on, arrangements were made to still further depart from the contract system, and wherever possible, carry out all works by the Council's own staff. This was done in order that the works might be more efficiently performed and fairer conditions of labour procured. It was decided that the wages paid should be at not less than trade union rates, and that the working hours should be 48 per week summer and winter alike.

In order to undertake such a department further accommodation was necessary, and the highways depot in Battersea Park Road was considered to be most suitable for the purpose owing to its central position. The original buildings were converted into stores, and new workshops erected at a cost of 4084*l.*

The latter consist of joiners', with joiners' machinery, wheelwrights', with wheelwrights' machinery, smiths', fitters', painters', harnessmakers', and plumbers' shops.

Joiners' Machine Shop.—Saw bench, panel planing machine, mortising and boring machine, saw sharpening machine, circular moulding machine, surfacing machine, and grindstone.

Wheelwrights'. Machine Shop.—Spoke copying lathe, band saw, rise and fall saw bench, general wheelwright, iron drilling machine, dovetailing machine, and saw sharpening machine.

Smiths' Shop.—Two double forges, three single forges, lathe, shearing and punching machine, smith's blow fan, grinding machine, vices, etc.

Fitters' Shop.—Engineers screw-cutting lathe, hand screwing machine, and hand drilling machine.

All the machinery is driven by a 25 h.p. Crossley gas engine, and a van-lift is provided for raising carts and vans to the wheelwrights' shop on the first floor.

The department is under the control of a superintendent of works, and a storekeeper has charge of the stores, both acting under the direction of the borough engineer.

As the works undertaken by the Council increased, the accommodation at the workshops and stores was found inadequate; at the same time, further wharfage accommodation was considered necessary, and the Council purchased Falcon and Grove wharves.

Portions of these were taken over by the electric lighting and highways departments, the remainder being utilised by the works department for unloading barges of material and for other purposes which could not be undertaken at Battersea Park Road.

A travelling crane is provided for unloading the barges, and a mortar mill driven by a portable engine for supplying mortar for building purposes and paving works.

Two saw benches, also driven by portable engines, have been erected on a gantry for cutting wood blocks. The planks, which arrive in barge, are deposited by the crane close to these and cut into blocks with a minimum amount of handling and consequently at a less cost than if the blocks were purchased ready cut and delivered on the roads by a contractor. A further advantage is obtained in this way as a large stock can be kept and delay avoided when carrying out works, as delivery compatible with the requirements of the work cannot always be relied upon.

A portion of the wharf is used as a mason's shop, and stone

for building purposes is delivered here in bulk and sawn and dressed as required for use in the works. Other accommodation provided at the wharf includes a cement store where the cement is cooled preparatory to use, and storage for grosser material, such as ballast, sand, pipes, kerb, setts, York paving, etc., the latter being delivered by barge and afterwards squared by the Council's workmen. In this way, it is found to be more efficiently done, as when delivered ready squared the arrises are always more or less injured in transit and handling.

The foregoing description of some of the works carried out will give an idea of the magnitude of the department, but it might be mentioned that since its inception in 1895 works to the value of nearly half a million have been completed, exclusive of small jobbing works.

Trades and Wages.

Building Trades:—
- General Foreman, £5 per week when engaged on large jobs.
- Bricklayers, 10½*d.* per hour.
- Do., gauged work, 11½*d.* do.
- Do., sewer work, 1*s.* 2½*d.* do.
- Carpenters and joiners, 10½*d.* do.
- Do., staircase hands, 11½*d.* do.
- French Polishers, 9*d.* do.
- Gas and hot-water fitters, 10*d.* do.
- Glaziers, 9½*d.* do.
- Joiner machinists, 11½*d.* do.
- Painters, 9*d.* and 9½*d.* do.
- Paperhangers, 9½*d.* do.
- Plasterers, 11*d.* do.
- Plumbers, 11*d.* do.
- Do. mates, 7½*d.* do.
- Scaffolders, 8*d.* do.
- Slaters, 9½*d.* do.
- Smiths, 10*d.* do.
- Do., hammermen, 8*d.* do.
- Stonemasons:
  - Banker, 10½*d.* do.
  - Fixer and granite masons, 11½*d.* do.
- Timbermen, rammermen and hoisters, 8½*d.* do.
- Zinc workers, 10*d.* do.

Miscellaneous:—
- Baths.
  - Attendants (male), 30*s.* per week.
  - Do. (female), 21*s.* do.
  - Laundrymen, 30*s.* do.
  - Stokers, 34*s.* do.
  - Money-takers, 21*s.* do.

Miscellaneous—
- Cemeteries.
  - Grave-diggers.
    - Foreman, 35*s.* do.
    - Diggers, 30*s.* do.
    - Attendants, etc., 30*s.* do.
    - Carter, 30*s.* do.
  - Gardeners.
    - Foreman, 35*s.* do.
    - Gardeners, 30*s.* do.
    - Under gardeners, 25*s.* do.
- Chaff-cutters, 30*s.* do.
- Chalet attendants.
  - Male, 28*s.* do.
  - Do., relief, 7*d.* per hour.
  - Female, 21*s.* per week.
  - Do., relief, 3*s.* 6*d.* per shift.
- Cleaners and attendants, Municipal Buildings and Town Hall, 30*s.* per week.
- Cleaner of Coroner's Court, 2*s.* 6*d.* each time Court is required.
- Disinfectors and drain-testers, 34*s.* per week.
- Drivers, 30*s.* do.
- Dust collectors, 30*s.* do.

Electric lighting department:—
- Lamp trimmers.
  - Foreman, 42*s.* do.
  - Lamp trimmers, 35*s.* do.
  - Do., mates, 30*s.* do.
- Jointers.
  - Foreman, 50*s.* do.
  - Jointers, 42*s.* do.
  - Do., mates, 30*s.* do.

Boiler room—
Foreman, 38*s*. per week.
Firemen.
Gangers, 37*s*. do.
Firemen. 34*s*. do.
Coal-trimmers, 7½*d*. per hour.
Engine drivers, 39*s*. per week.
Fitters, 42*s*. do.
Engine drivers.
Stationary engine drivers, 36*s*. do.
Road-roller drivers, 36*s*. do.
Farriers.
Firemen, 42*s*. do.
Doormen, 36*s*. do.
Flag boys, 10*s*. do.
Foreshoremen, 32*s*. do.
Garden attendants, 30*s*. do.
Harness-makers, 10*d*. per hour.
Horsekeeper (Highways), 50*s*. per week, with residence.
Do. (dusting), 37*s*. 6*d*. do., do.
Do., assistants, 35*s*. do.
Labourers and navvies.
At dust depot, 30*s*. do.
At stores, 30*s*. do.
Ordinary, 7½*d*. per hour.
Laying tar-paving, 7½*d*. do.
Hand linemen (sewer work), 8½*d*. do.
Concrete levellers and pan-men, 8*d*. do.
Breaking-up roads and screeding in connection with wood-paving; and (at the discretion of engineer) when engaged on offensive sanitary works, 8½*d*. do.
Libraries—
Assistant caretakers (male), 30*s*. per week.
Cleaners, 7½*d*. per hour.
Sunday attendant, 7½*d*. do.
Masons (paviors), 10½*d*. do.
Mortuary keeper, 35*s*. per week, with residence.
Office boys or messengers on works, 10*s*. per week.
Roadmen—
Inspectors, 40*s*. per week.
Do., 35*s*. do., with residence.
Gangers, 32*s*. do. (when actually engaged on levelling, 6*d*. per day extra).
Men, capable of performing any work required on the roads, 30*s*. per week. When engaged on levelling, 6*d*. per day extra. Only capable of performing the light work required on the roads, 28*s*. per week.
Tarpaulin-makers, 32*s*. per week.
Sewer flushers—
Foremen, 38*s*. per week.
Flushers, 36*s*. do.
Shootmen, 30*s*. per week.
Stable-helps, 7½*d*. per hour weekdays, 1*s*. 3*d*. per hour Sundays (total hours not to exceed 48 per week).
Stokers and feeders—
Foremen, 36*s*. per week.
Stokers, 34*s*. do.
Timekeepers, 30*s*. do.
Watchmen, 7½*d*. per hour.
Wheelwrights, 10*d*. do.

In conclusion, the Author would like to express his thanks to all those who have rendered him assistance in the arrangements for this meeting, especially mentioning the assistants in his own department, the Town Clerk, the Assistant Town Clerk, Mr. Alex. Millar, A. M. Inst. C.E., the Resident Engineer of the Tramways, and Mr. R. M. Gloyne, M. Inst. C.E.

The Author's thanks are further due to the Council for their kindness in placing the several buildings and depots at the disposal of the Association for this meeting.

DISCUSSION.

Mr. J. LEMON: I have pleasure in proposing a hearty vote of thanks to Mr. Hayward for his paper. With tar macadam so much depends upon the way in which the tar is mixed. First of all you want the proper tar, then the proper preparation, and then you want skilled men to make it. Mr. Hayward has referred to the incessant opening of the streets for gas, water and other purposes, but I must congratulate Battersea on getting the whole of these openings made good by their own workmen. I cannot help noticing the enormous cost of 2*s.* 10*d.* per cubic yard for the disposal of refuse after being placed in the barge. There is no other place I know of where such an enormous cost has been incurred; I know the high cost is inevitable, but does it not point to this—the sooner you get rid of gravel roads, the better? As to the collection of refuse my experience is that a collection once a week is quite often enough. Where you try to remove it more than once a week, the men become a nuisance, and householders tell them they do not want to be bothered with them.

Mr. J. LOBLEY: I desire to second the vote of thanks to Mr. Hayward for his paper. The price charged for the electric arc lamps seems very small, but of course a good deal depends whether they are alight all night. If the lamps are extinguished at midnight, it reduces the consumption of current by one-half.

Mr. W. HARPUR: I should like to know what kind of slag is used and where obtained; what kind of tar is used—the proportion of tar used to a given quantity of slag and the method of mixing? Is the tar applied hot or cold, also is the slag heated, and if so, by what means? Is any other material used with the slag and tar; and if so, what and in what proportions? Then how does the tarred slag macadam stand omnibus traffic as compared with Guernsey granite macadam? I should like to know the candle-power of the large and the small electric lamps, and of the Nernst lamps respectively. Are the Nernst lamps a success? Does the electric light department provide lamps and pillars, and include the cost of carbons and repairs, lighting and extinguishing for the price given in the paper?

Mr. A. M. Fowler: I see by the paper you have three miles of granite sett paving in Battersea, laid I suppose as an experiment. Granite paving is admitted by everyone who has used it to be the most economical so far as cost is concerned of any paving you can put down in a large town with heavy traffic. The great fault of the paving there is that it has been laid down such a length of time, that the arrises of the stone have worn away and the noise of the traffic passing over it is great. With regard to the collection of refuse, a good deal might be done, as is done in many houses, by the burning of all domestic refuse on the kitchen fires. If you notice the refuse to be burnt at some of our destructors, you will find large quantities of garbage, and filth, all liable to ferment and so becoming a great nuisance.

Mr. O. E. Winter: The price of hardwood paving strikes me as being high. I should expect to get the foundation put in for the price of 13*s.* 6*d.* per super. yard. With respect to the sectional blocks, I think I was the first engineer to put these down in London. These were laid seven or eight months since at Edgware Road, Kilburn. It is a hardwood block I have been anxiously looking after, because I think it will overcome the difficulties met with in hardwood paving, more especially the shrinkage of the blocks in hot dry weather. The blocks being put down in this sectional form and thoroughly bound together this difficulty is got over. The result has been that throughout the winter there has been no movement observable in the pavement. Although the blocks have been laid in a road 50 feet in width there has been no expansion; and it has not been necessary to adjust the kerbs. So far as I can see there will be no shrinkage during dry weather, which is a very important element in paving. It seems to me these blocks are very promising material for wood paving. Another point is that the blocks are almost as noiseless as creosoted deal blocks, certainly much quieter than ordinary hardwood paving. This is attributable no doubt to the pitch grouting round the sections of the blocks. As to tar slag macadam, I have put it down, and it is a very good pavement. I have not yet put it down in streets where there is heavy traffic, but in side streets and cul-de-sacs, where children make their playgrounds. The obstacle in putting it down is the cost: 3*s.* or 4*s.* per yard. To put it down to a large extent would incur a very large expenditure. I have adopted a plan which to some extent approaches the surface of tar macadam, and

reduces the dust on ordinary macadam roads, by using : Westrumite. This is put over the road under repair wl roller is doing the last rolling. I tried this in a road tw ago, and there has been less dust on the road in summ less mud in winter. I think it a safe estimate to say will add 30 or 40 per cent. to the life of the road. ' done at the cheap cost of 1*d*. to 2*d*. per square yard. As repair of trenches, I should like to know whether Mr. H has an agreement with the General Post Office to p schedule rates mentioned. With reference to scavengin quite true that the adoption of more permanent materials r the cost of scavenging. During the last six years, altho have added six miles to our roads in Hampstead, the removing slop has been reduced. It is unfortunate for Ba that it does not possess a good central depot with thei works. It is a very great advantage in the administratic district. With reference to the collection of refuse it app me that so far as London is concerned the collection of refuse should be carried out at least twice a week, and rather surprised that Battersea has not come up to date i respect. With regard to street lighting I observe that it apparent intention of the Battersea council to extend the e incandescent lamps in many of their streets. I doubt w that is an economical or effective course. In Hampste have recently removed some incandescent electric lamp substituted incandescent gas, with good results; obtair better light at less cost. I quite admit that so far as wide roads are concerned that the arc lamps are the most econo

Mr. R. J. Angel: With reference to the frequent coll of house refuse, Mr. Fowler does not recognise that in L we go in very largely for gas fires, and therefore it is quit possible to consume the refuse on the kitchen fire. If the h hold refuse is allowed to accumulate for a week, it becomes a large item. In my district the dust is collected twice, a some cases even three times a week. The question of gas e electric light is one which has been occupying the attention good many councils. I notice the cheapest price for ele light is 6*l*. per lamp per annum, whereas the Gas Light Com look after and maintain a lamp for 3*l*. 3*s*. 9*d*. per annum, a believe it can be done for even less than that. In referen this, I should like to know what it is that has influenced

Battersea borough council in still pushing forward the electric light, because it seems to me in a progressive borough, one should study the ratepayers' pockets, and give them what in my opinion is a better and more uniformly distributed illumination. I should like Mr. Hayward to give us his experience of Norwegian setts. My own experience is that Norwegian setts are very soft, and not at all suitable to heavy traffic. Sectional blocks are not a new thing, having been in use ten or twelve years, but I think the difficulty with them is overcome in the present type by the elimination of the metal clip. I have seen the new form of blocks which are secured by a groove and fillet. I do not think that efficient work can be secured from men working on the streets at an advanced stage of life. My council have adopted the principle of draining the water from the road slop in order to give the contractor only the solid material. If Battersea did that they might reduce the cubic capacity and the annual expenditure. Reference is made in the paper to artificial flags, and I wish to ask Mr. Hayward's opinion of the dual materials. I have heard it said that the upper surface scales away and that it is occasionally necessary for the workmen to go out to attend to them. There is a flag on the market which in the early days of its history was formed of two thicknesses of different material. I had an unfortunate experience with those flags, the tops simply scaling off, a portion coming away from the bedding underneath. It is possible with the same machinery to make the flags with two faces, and so be able to turn them when the top surface is worn away, which cannot be done if the small thickness is used. As to the wood on the margins of the tramway, my own impression is that Karri has a great tendency to corduroy. I should have thought that Jarrah would have been the better of the two. I should like to know the price per cube foot of the stables which have been erected. In my own borough stables have been erected by me at 9½*d.* per cubic foot. I see that the borough engineer was instructed to prepare revised plans based upon the premiated designs for the artisans' dwellings. That I regard as a very retrograde step, and one which ought to be strictly discouraged in any council which aims at purity in commercial life.

Mr. NORMAN SCORGIE: If the Members will look at the statistics a good many will be surprised, when comparing the total rates, to see how little the borough councils are responsible

for. In Battersea of the total rate of 4*s*. 2*d*. only 1*s*. 5*d*.
expenditure over which the borough council have control. T
fore, of every 1*l*. collected in rates the Battersea council have
to deal with 6*s*. 8*d*. I agree with Mr. Winter that the pr
wood paving, of 13*s*. 6*d*. per yard without foundations, is ex
ingly high, especially when it is borne in mind that the b
would not cost more than 9*s*. thus leaving 4*s*. 6*d*. for layin
grouting up. Reference has been made to the sectional
blocks. I am one who has tried this paving and subjecte
heavy traffic, and have formed a very good opinion of it
noise is very much less than with ordinary wood paving,
think with Mr. Angel that the present sectional wood b
remove many of the objections which are made to blocks
metal clips. Mr. Winter has referred to the Post Offic
arrangements as to making good street openings. Of al
people I have to deal with they are the hardest to make a ba
If Mr. Hayward succeeds and gets the price put in the sch
he ought to be congratulated. Take the first item, York p
relaid 2*s*. 3*d*. per super. yard. That is a very good price.
regard to scavenging we can hardly congratulate Batterse
the decision that no man is employed on the highways und
years of age. In the interests of the men, I think that is w
In the metropolis we are more favoured than in the provi
and are enabled to give workmen superannuation. If a
has to begin work at 40 years of age and over, what pos
chance has he of putting in sufficient years service to secu
proper superannuation. At 65 he has put in 25 years, and
superannuation allowance is 12*s*. 6*d*. per week. I think
advisable that we should have our men at the prime of life.
a man comes to us at 25 years of age, and stays 40 years
goes away with 1*l*. a week superannuation. As to the rem
of house refuse it is stated that the total amount is 60,000 t
per annum. That is a very excessive quantity, and I sho
like to ask if some mistake has not been made in the figu
In Hackney with a population of 227,000, we get 38,000 tons
annum. We collect once a week and in one or two main str
more frequently. In Islington, with 335,000 people the ref
only amounts to 55,000 tons per annum. Taking six person
each house it amounts to 36 cwt. per house per annum
Battersea. I suggest to Mr. Hayward that he has multipl
the 32,000 loads by two instead of 1½, which Mr. Barber find

the correct figure in Islington. As to lighting it is not safe to make comparisons on the figures. The 259 large electric arc lamps are charged at 18*l*. per annum. One is not able to decide whether that is a reasonable or excessive charge, because no information is given as to the number of hours they are lighted. I cannot congratulate Battersea upon its adoption of the Nernst electric lamp. In Hackney we have discarded them, after their being tried and found wanting. We paid 4*l*. per annum for them, and Battersea is paying 50 per cent. more. There is nothing in the paper as to substituting incandescent electric for incandescent gas lamps, as supposed by Mr. Angel. Battersea apparently contemplates doing away with the old flat flame gas burners and putting in arc lamps. If Battersea can afford it, they are progressive in that direction and economical. Battersea is suffering, like all boroughs, in respect of the confusion in the law as to sewer *versus* drain, and I hope will support those borough councils who want to see the law altered. Their contribution to the property owners has exceeded 2200*l*. per annum for the last nine years. My experience is the same, and I think it may be safely said that the ratepayers of London are paying 50,000*l*. a year which the owners should morally and equitably, if not legally, pay.

Mr. A. H. Campbell: Reference has been made to the low general district rate of Battersea, and with all the enterprise of this borough, a rate of 1*s*. 5*d*. is most moderate. As compared with extra metropolitan suburbs, you must bear in mind that Battersea has the advantage of the London County Council, the Metropolitan Asylums Board, fire defence, the main drainage, parks, and certain other advantages. If these were added, the rate would be brought up to 2*s*. or 4*s*. per annum, which is about the average. Undoubtedly tar macadam is the acme of cleanliness. I find that every work is measured by a professional valuer, I think that is the most effective method of check as to the validity, fairness, and propriety of the tenders submitted by the works manager, and if that example could be followed in other towns, works departments might thrive on a fairer and surer foundation than now exists.

The President: Mr. Scorgie has referred to the various charges made by Battersea for making good trench openings by the various companies. In fixing those charges, the question of establishment charges ought to be borne in mind. I am

afraid many of the towns do not bear it in mind. I have always been in the habit of adding something to the cost of the work for the cost of the establishment. Recently I was questioned on that point, and went into figures. I have been charging from 10 to 15 per cent. I found the proper charge was 10 per cent. In that is included rent of stores, capital payments for buildings, and the wages of everybody connected with the superintendence of labour, the keeping of stores and time-keeping, but nothing for office (i.e., Guildhall) expenses. Then I have made a bargain with various people that we should charge an additional amount to cover third party risks. You are all aware of the fact that if you do work for a water company, or any other company, and if any accident happens whilst the works are in your charge, your Corporation, not the company, is liable, and you ought to safeguard your Corporation against that liability.

Mr. T. W. A. HAYWARD: I am very much obliged to you for the hearty vote of thanks you have passed. The price of barging away the refuse was the lowest tender received. It does add seriously to the cost of scavenging. The public lamps are lighted 3940 hours per annum. The lamps are put fairly close together, and the street lighting is second to none in the kingdom. In reply to the series of questions put by Mr. Harpur, I may say the slag which has proved such a success in Battersea, is what is known as ironstone slag, and is obtained from Wellingborough, every stone being packed by hand to ensure good material. The slag is broken to a uniform gauge and mixed with refined tar, while both are hot, in a machine specially designed for the purpose by the contractors. No other material is mixed with it. I find that this slag tar macadam is suitable for heavy traffic as well as light traffic, and gives absolutely the best results of any tar macadam I have used or seen. I might perhaps refer to the experiment that the London County Council has carried out on the Thames embankment. Members of the London County Council visited and inspected the roads at Battersea and determined to lay some of their roads with tar macadam. They put down three sections, slag, granite, and limestone. After a few months the limestone tar macadam was worn through, the granite tar macadam was broken all to pieces, but the slag tar macadam is as good now as when it was first put down. It may be of interest to the Members to know that according to a recent police report nearly 10,000 vehicles pass over this portion of the

embankment every twelve hours. The first road put down with this material on an omnibus route did not need any repairs for two years, and then it was only painted and sprinkled with slag chippings at a cost of less than *2d.* per yard, although continuously used by omnibuses; while on the other hand a length of road adjoining the tarred slag macadam road has been repaired four times in the same period. The candle power of the large arc lamps is 1000, of the smaller ones 500, and of the Nernst lamps 64. The cost given for lighting includes maintenance, upkeep, and all other charges. Half the lamps are alight all through the night, the remainder being put out at midnight. The Nernst lamps are successful. The three miles of granite pitching was not laid as an experiment, but to withstand the heavy traffic. Where new granite pitching is laid, the special dressed setts, as described in the paper, are used. These setts present an even surface and when properly laid with close joints the noise from the traffic is reduced to a minimum, which fact, in time, will, no doubt, bring that paving more into favour. Mr. Winter has called attention to the price of wood paving as given in the paper. The cost of Karri blocks, which are the kind always used in Battersea, is very high at the present time, which will account for the seemingly high figure. I believe the contractors on the tramways reconstruction work are now paying 13*l.* or 14*l.* per 1000 for 9 in. by 3 in. by 5 in. blocks. The Battersea works department buy the planks and cut them into blocks. I was glad to hear what Mr. Winter said in favour of the sectional block. I am of opinion that that particular kind of paving will be largely used. In regard to the collection of refuse, reference to the paper will show that Battersea is up-to-date. As to a central depot we find the want of it a great difficulty, but as Battersea grew so rapidly it would have entailed an enormous cost to have bought land for a central depot, so we did the next best thing and built depots in different parts of the district. In reply to Mr. Angel's query in reference to street lighting, the borough owns the electricity works, and that is no doubt the reason why that kind of light was adopted. In regard to the life of Norwegian setts, my opinion is at variance with Mr. Angel's. Some Norwegian setts are undoubtedly as good as any that can be obtained in this country, while of course the cost is very much less. The old men referred to as employed on the roads, are generally men that have been in the council's

service in other departments, and as old age comes upon them they are put to work upon the roads as being the most suitable employment that can be found. Mr. Angel may perhaps be surprised to hear that in Battersea the water is drained from the slop to a certain extent before the slop is placed into the barges. The flags made by the works department do not scale, and I have never had occasion to replace a flag after it has been laid. Double faced flags are not a success. The price for the stables was 10*d.* per cubic foot. As to the designs for the artisans' dwellings, I should like to say that I have fully qualified architects in my office, and one of them, who is a member of the Royal Institute of British Architects, is well known to many Members present, and is one of the most successful architects that any borough engineer has the pleasure of numbering on his staff. In Battersea the first roadway laid with tar slag macadam was laid in the way I thought best. The bus-drivers complained when it was first laid that it was soft, and my council said, when the next road was under consideration "cannot you lay tar macadam with a thin coating of fine stuff on the top, just sufficient in thickness to make it waterproof." After the busses had run over a road so laid a short time it was worn through. That is the explanation. In the other streets, where we have 1¼ inch of topping, we have not had this trouble. As to the repair of trenches; in some cases trenches measure only about 1 foot super., for which we have to send a man out, and instead of making a profit it is the other way about. I think we treat very liberally those who break up the streets. There is no mistake about the quantity of dust. The quantity mentioned includes trade refuse and costers' refuse, which is very heavy in Battersea. I can assure Mr. Scorgie that Battersea will not be behind in the combined drainage question. I should like to thank Mr. Campbell for his words about the works department. The works department at Battersea is often misrepresented. I am a strong advocate of direct employment, and when a council will have confidence in their surveyor he can do the work as well as anyone else. It has once been suggested in Battersea that the quantity surveyor made his price high to assist the works department. In order to show that it was not so, the council asked those who were opposed to the method adopted to nominate their own surveyor to take out the quantities and prepare the estimate. This challenge was accepted, and when the quantities and estimates came in, they were very much in excess

of what the works committee had agreed to accept, and of course the advantage was with the council. I appreciate the vote of thanks you have so generously accorded me, and am glad the paper has evoked so good a discussion.

The Members were hospitably entertained to luncheon in the Grand Hall of the Municipal Buildings.

The afternoon was devoted to visits, made in motor omnibuses, to the Latchmere Estates Artisans' Dwellings, the Swimming Baths, Mortuary, Coroner's Court, the Works Depot, Battersea Park, and other places of interest.

At the conclusion of the visits, Mrs. Hayward kindly entertained the Members to tea at the Town Hall.

YORKSHIRE DISTRICT MEETING.

June 1 and 2, 1906.

Held at the Town Hall, Scarborough.

A. E. COLLINS, M. INST. C.E., PRESIDENT, *in the Chair.*

THE Mayor (Ald. W. H. Hastings Fowler), received the Members, and offered them a hearty welcome to Scarborough.

The President, on behalf of the Association, thanked the Mayor for the kind welcome he had given them.

The minutes of the last Yorkshire District Meeting were read, confirmed and signed.

The President referred to the great loss the Association had sustained in the death of Mr. W. H. Hopkinson, Hon. Secretary for the Yorkshire District.

Mr. H. W. Smith, Borough Engineer, Scarborough, was unaminonsly elected as Honorary District Secretary.

MUNICIPAL WORK IN SCARBOROUGH.

BY H. W. SMITH, A. M. INST. C.E., BOROUGH ENGINEER.

THE past ten years in Scarborough have been from a municipal engineer's standpoint "fruitful years," and it is the intention of the Author in this paper to very briefly refer to a few of the more important and interesting of these with which he has had the privilege to be associated.

The history of the ancient borough of Scarborough has already been given in a previous paper at a visit of the Association, and the Author does not propose to again repeat it, but will merely give a few facts with regard to the population, rateable value, etc., which are as follows:—

The area of the borough is 2562 acres 5 poles. The popula-

tion at the last census was 38,160; it is now estimated at 40,180. The rateable value is 248,635*l.*

Scarborough has been famed for years past as one of the chief health and pleasure resorts of the North, and it has always been the policy of the Town Council to spare no pains to maintain and increase its reputation.

Passing on to the works which, as far as possible in the time at the Members' disposal, the Author will endeavour to show, the following are amongst the more important:—

Town Hall.

The building in which the Members are now assembled has been the home of the Corporation for the past three years, previous to which the various departments were housed in the old town hall in Castle Road and other buildings the property of and rented by the Corporation, an extremely inconvenient arrangement, whilst the accommodation provided was limited and not in any way worthy of a borough of the size of Scarborough.

In 1898 it came to the knowledge of the Corporation that the estate of the late John Woodall, Esq., comprising St. Nicholas House and its grounds, extending to the South Foreshore Road, and a large wooden building now known as Olympia, were in the market; an offer was made on behalf of the Corporation, and the bargain concluded by the unanimous vote of the Council for the sum of 33,575*l.*

The Author was instructed to prepare schemes showing how St. Nicholas House could be adapted for municipal offices, and after many plans had been prepared and considered, a scheme of alterations on the present lines was approved, and the work, as the Members see it to-day, carried out at a cost of 21,386*l.*, including furnishing.

Members will fully appreciate the difficulty of converting a building originally designed as a dwelling house into a municipal building, the result of which must be always more or less disappointing.

An endeavour has been made throughout the work to adhere to the style of the existing building, which was built from the designs of W. H. Wyatt in 1845.

The buildings provide accommodation for the Council, the town clerk, medical officer, borough engineer, water engineer, borough accountant, rate and education departments.

The police and court-house are still remaining at Castle Road, but it is intended that the whole of the departments should be accommodated on the St. Nicholas House site, land adjoining having been acquired for the purpose.

Highways and Footways.

The total mileage of public highways in the borough is 41 miles 1415 yards, of which 4 miles 1723 yards are main roads.

Scarborough has for many years enjoyed a reputation for the excellence of its tar-paved roadways, being one of the pioneer towns in respect of this particular class of work. Much of the success attained is largely due to the care and attention of the Author's predecessor, the late Mr. J. Petch. The Author feels that this class of roadway might be more generally adopted in many boroughs where the traffic is light, as they possess the advantage of being dustless, sanitary, and economical, the cost of the upkeep being reduced to practically a minimum.

Sections have been cut out from roads which have been laid down for upwards of twenty years, and they will speak for themselves.

There are many forms of tar paving now on the market known by various names, which will be familiar to Members, but the Author only proposes to give a short description of the methods adopted in Scarborough which differ from these.

Description of Preparation and Laying of Tar-Paved Roads.

The subsoil of the borough is boulder clay, and as one of the chief factors in the life of a tar-paved roadway is an absolutely dry foundation, the foundation of a roadway of this class consists of 3 in. of sand upon which are laid 7 in. of local sandstone or broken bricks, hand paved, all interstices being filled in with a layer of gravel 3 in. thick (obtained from the beach).

This formation is consolidated and shaped with either a heavy horse roller or light 8-ton steam roller, when it is ready to receive the tar paving, which consists of three coats as follows :—

First Coat.—The first coat is composed of local limestone gathered from the beach along the coast and broken to a $1\frac{3}{4}$-in.

gauge, then placed on the hot plates or drying kiln about 8 in. thick, and left till thoroughly dry.

After all moisture has been driven off, the stone is turned off on to a platform and mixed, whilst hot, with cold gas tar direct from the works, about ½ cwt. to 1 ton of stone. It is then deposited in heaps ready for use, and is better for being kept two or three months, which remark applies to all classes of tarred stone.

Second Coat.—The second coat is composed of water-worn gravel from the beach, screened to 1¼-in. gauge, and is prepared as follows: A layer of gravel about 5 in. thick is put on to the hot plates, and is covered by 1¼ in. screened gas-works cinders about 1 in. thick, then another 5 in. of gravel covered with a thin layer of cinders, the whole making about 12 in. thick. When the material is thoroughly dry it is turned over, mixed, and tarred as above—about 1½ cwt. of tar to 1 ton of material.

Third Coat or "topping."—The finishing coat is a mixture of fine gravel and ashes, both screened to $\frac{5}{16}$ in. About 5 in. of gravel are first put on to the hot plates covered with 3 in. of ashes, then another layer of 5 in. of gravel, and a further covering of 3 in. of ashes—in all 16 in. thick. When dry it is turned over and thoroughly mixed, and then incorporated with tar in the proportion of 2 cwt. of tar to 1 ton of material.

Each coat is well rolled in with an 8-ton roller as it is laid on, and the finished surface is sprinkled with local limestone chippings, which considerably brighten the appearance of the road.

The total finished thickness when rolled averages about 4½ in.

After an interval of about twelve months, or sooner if required, in about the months of May and June, in fine weather when the road surface has absorbed the heat of the sun, the surface is painted over with cold tar, and sprinkled with fine gravel and limestone chips, and rolled with steam roller.

This process is repeated every two or three years as necessary, and is the main factor in extending the life of the road. The cost per yard superficial of a roadway of this class (without foundation) is about 2*s.* 6*d.*

The cost of tarring and dusting (including such slight repairs as may be necessary) is about 1¾*d.* per superficial yard.

The Author has experienced some difficulty latterly in obtaining tar of an equal quality to that supplied some years ago before the attention of Gas Companies was directed to the extraction of the by-products. Nevertheless, by care and rejection of inferior samples, it is still possible to obtain satisfactory results from the tar now obtained without the addition of other ingredients.

The Author does not claim for the above form of tar-paved roadway that it is a superior form to a similar roadway constructed of properly tarred limestone broken to a gauge, but ventures to draw the attention of Members to them on account of their low cost and as showing that it is possible to produce a satisfactory roadway from material which cannot be described as "ideal" for the purpose.

The Author has laid down considerable areas of creosoted redwood paving, basaltic lava and West Riding of York setts, but as they are of the usual type none call for any special description.

Footpaths.

The footpaths of the borough consist of York flags and limmer asphalt in the main thoroughfares, the remainder being of tar paving.

The tar-paving footways are laid on a foundation of sand and 4 in. broken brick and consist of a coat of water-worn beach gravel broken to a 1¼-in. gauge with a finishing coat of fine cinders and gravel similar to that described for tar-paved roadways; this is well rolled with a 5-cwt. hand roller, and a sprinkling of Derby spar or West Riding chips added to brighten the surface. These footpaths are tarred and dusted in a similar fashion to the roads with the exception that the materials used are of a finer nature.

The cost of the footways exclusive of foundations is 1*s.* 3*d.* per yard super.

Street Improvements.

A number of important street improvement works in the nature of widening and improving streets have been carried out, involving an expenditure, including the purchase of property, of 50,789*l.*

Sewers.

The sewers of the town are divided into two systems discharging direct into the sea, the southern system having its outlet near the east pier, and the northern at Scalby Nab, about a mile north of the borough.

Ventilation is effected by means of 4 in. and 6 in. cast iron pipes carried up the ends of houses wherever permission can be obtained to do so.

Like many old towns, many of the sewers are unprovided with means of inspection and it has been the practice of the Author to insert man-holes for this purpose from time to time as opportunity occurs.

Since the Author's appointment all man-holes have been constructed with a lining of salt glazed bricks, and much has been done to improve the general sewerage system of the borough.

Marine Drive.

The new marine drive, now in course of construction, forms the connecting link between the promenades on the South Foreshore Road, in the south bay, and the Royal Albert Drive, in the north bay, and will, when completed, form one of the finest marine drives possessed by any watering place in the United Kingdom, it having a total sea-frontage of about 2¼ miles.

The drive encircles the base of the bold headland known as the Castle Hill, and serves the twofold object of providing a magnificent and unrivalled marine carriage drive and promenade, and protecting an historic landmark from the erosive action of the sea.

Its length of 4100 ft. from the end of the Albert Drive, in the north bay, to the junction with the east pier, in the south, does not convey any idea of the magnitude of the work. To realise this, one must needs first have viewed the beach at the foot of the Castle Hill before the commencement of the work. This beach was strewn with titanic boulders which had fallen from the cliffs above as the result of centuries of buffetings from north east gales and the action of the wind and weather. Before a single foundation block of the wall could be laid these had to be removed by blasting and steam cranes.

The sea-wall, which is built upon the Oxford clay (or shale),

forming the base of the cliff, varies in thickness from 17 ft. 6 in. to 33 ft. 8 in. at its base to 6 ft. and 10 ft. at the top, and in height from 32 ft. to 38 ft. according to its varying degree of exposure to the forces of the north easterly gales; it presents a concave face to the sea, and is constructed of cement concrete blocks, backed up by concrete in mass, the blocks varying in weight from 9 tons, in the toe blocks, to 1½ ton as the top of the wall is reached.

Over 71,000 cubic yards or 113,000 tons of concrete have been used in the construction of the wall.

The level of the top of the sea-wall is 19 ft. above high-water mark at O.S.T., whilst its toe, for the greater portion of its length, is slightly below low-water mark, a circumstance which has added considerably to the difficulty of the work.

The space at the back of the wall has been filled in by material taken from the cliff, over 237,000 cubic yards of material being required for the purpose. Upon this filling is formed a carriage road and footpath 60 feet in width. The footpath is 20 feet in width and is on the sea side of the road. The space between the roadway and the base of the cliff is fenced in by a stone dyke wall which protects the roadway from any boulders or loose stones which may fall from the cliff.

The work was commenced in the spring of 1897, and the time for completion expiring in 1899. Owing to the exceptional difficulties which were met with in the laying of the foundations and the loss of the gantry erected for the purpose of the works by gales, it was September 1904 before the two ends of the wall (which were proceeded with simultaneously) were joined up, the last block being laid on October 1, 1904. There yet remains to finish the paving of the surface of the drive at an estimated cost of 8000*l.*, and the erection of toll-houses at an estimated cost of 1200*l.*, and the reinstatement of certain portions of the wall which were damaged during construction by gales.

Previous to the commencement of the work and during its progress, the Corporation had the benefit of the advice of several eminent engineers skilled in sea defence works, whilst the actual superintendence of the work has been carried out under the direction of Mr. J. B. Everett, Assoc. M. Inst. C.E., Mr. E. T. Beard, M. Inst. C.E., and latterly by the Author who is completing the work.

The estimated cost of the work is approximately 110,000*l.*

A system of electric tramways will traverse the drive from end to end, connected with the tramway system in other parts of the borough.

Approach Road to Marine Drive.

In order to form an approach road to the Marine Drive at its southern end and connect it with the South Foreshore Road, the Corporation have cleared away a number of old warehouses and cottages abutting on the harbour, and have constructed a roadway with a minimum width of 60 ft. This work has been carried out by the Author, in conjunction with the late resident engineer of the Marine Drive, at a cost of about 15,000*l.*

Sea Defence Works.

As will be seen by the Members, the question of sea defence works is one of great importance, and in this respect Scarborough differs little from other towns on the east coast which are suffering severely from the erosion of the cliffs by the action of the sea.

A sum approaching 150,000*l.* has already been expended on the construction of sea walls, and the Author is strongly of opinion that the time has arrived when steps should be taken to obtain some aid, either by a grant from the National Exchequer or by sanctioning loans at a low rate of interest, and the extension of the period for the repayment of same.

The construction of the sea walls has created additional scour, and it has been necessary from time to time to construct and extend aprons in front of the same. These remarks particularly apply to the Royal Albert Drive in the north bay where the bed of the sea, consisting of shale, has been eroded to a depth of 7 ft. since the construction of the wall in 1888.

The Author is now constructing four experimental wooden groynes, and already an improvement in the state of the beach is observable.

Public Lavatories.

Considerable attention has been paid by the Council to the provision of lavatory accommodation in the borough, and the Author has constructed a number of lavatories for both sexes, both under and above ground, at a total cost of over 4420*l.*

Attendants (male and female) during the season are provided at such of the lavatories as are fitted with washing accommodation, etc., the remainder have automatic locks fitted to the w.c.'s, and are visited periodically by an attendant. A revenue of 565*l.* was obtained from this source during the past year.

Pleasure Grounds.

Scarborough is very happily situated in respect of public parks and pleasure grounds, there being no less than eleven of these distributed over the borough. Whilst none of them are of any great extent, they present many unusual and interesting features, owing, in the main, to their being constructed upon the sides of cliffs in both bays.

The Author has laid out the St. Nicholas Gardens (which adjoin the Town Hall), the Esplanade and extension of Holbeck Gardens, Falsgrave Park, Manor Road Recreation Ground and Bowling Green, in addition to the establishment of a nursery garden in which all plants and shrubs for the above are reared.

Corporation Estate.

The Corporation have been from time immemorial the owners of an estate known as the Weaponness Estate, comprising 557 acres.

The estate comprises agricultural land and farm buildings, woods and plantations (which are open for the enjoyment of the public), and building land.

The Author has laid out and developed a large area of this estate in building sites, which should in years to come afford a considerable relief to the rates.

Infectious Diseases Hospital.

The provision for dealing with infectious diseases, other than small-pox, prior to, and at the date of the Author's appointment, was totally inadequate for the needs of the borough.

The cases were treated in the governor's house of the old gaol, two old warders' cottages, and a brick building constructed

originally during a small-pox scare, whilst the administrative work was carried on in a small adjacent villa.

This arrangement was strongly condemned by the Local Government Board officials, and the attention of the Council was continually being drawn to the need of better and more modern accommodation.

The Author was instructed to prepare plans for a new hospital on the pavilion system, to be erected on a site about 1¼ mile from the centre of the town and outside the borough boundary, at an estimated cost of 15,000*l*.

After much discussion, plans were finally approved and adopted, and the work of erection commenced in 1902, the buildings being ready for occupation in March 1904.

The accommodation provided in the hospital consists of the following :—

Administrative Block.—Contains accommodation for medical officer of health, matron, nine nurses, six servants, kitchen for the whole hospital, and the usual offices.

Scarlet Fever Block.—Contains accommodation for six male and six female patients in main wards, and for two patients in private wards. A recreation room is provided on the first floor.

Enteric Fever Block.—Contains accommodation for four male and four female patients in main wards, and two patients in private wards.

Diphtheria Block.—Contains accommodation for patients in the wood and iron structure erected in 1892 for the isolation of small-pox.

Observation Block.—Contains accommodation for one male and one female patient.

Laundry Block.—Contains wash-house, ironing-room, engine-room, boiler-house, coal-house, disinfecting chambers, stable and coach-house, mortuary, and incinerator.

Porter's Lodge and Discharge Block.—Contains accommodation for porter, waiting-rooms, bath-room, dressing-rooms, clothes stores, and the usual offices.

The buildings are of brick with stone dressings, faced with local red wire-cut bricks, and have slated roofs.

A special feature of the sanatorium is the provision of private wards for the reception of paying patients—a scale of charges for which can be obtained on application to the medical officer of health.

Throughout the interior of the buildings all internal and external angles have been rounded off to prevent accumulation of dust, and a specially hard plaster has been used for the walls and ceilings of the ward blocks.

The wards of scarlet, enteric, and observation blocks are heated by means of Shorland's Manchester stoves and grates (double stoves being provided in each of the large wards of the scarlet and enteric fever blocks). Supplementary and independent heating is provided in the two latter pavilions, and in the administrative block, by means of radiators on the low pressure hot-water system. Each pavilion is also provided with a distinct system of hot water supply separate from the heating system.

All wards are ventilated by means of inlet ventilators at the floor level, and by exhaust ventilators in the ceiling on the "natural system." In addition the upper portions of all windows are arranged to open inwards on the hopper principle. By means of a deep bead at the sill, ventilation can also be obtained at the meeting rails of the upper and lower sashes of each window, a principle which has been extended to all windows in the administrative block as well.

The wards are lighted by means of incandescent gas.

The floors of wards consist of polished oak blocks on concrete. The floors of corridors, bath rooms, lavatories, etc., are of "Terazzo."

The sanitary fittings throughout the various buildings are of the latest and most approved type.

The laundry has been fitted with steam power plant, consisting of engine, boiler, washing machine, washing troughs, hydro extractor, rinsing and boiling tanks, sparger and ironing machine, and drying horses, all of the latest pattern.

The steam disinfecting apparatus is of the Washington-Lyon type.

The drainage of each block is disconnected from the main drain and properly ventilated. Inspection chambers of salt glazed bricks are provided at all bends and important junctions.

The various blocks are in communication with the administrative block by means of a local telephone exchange, whilst the sanatorium is connected with the National Telephone Co.'s Exchange in Scarborough.

The grounds have been laid out and planted with trees and shrubs. A croquet lawn has been formed in front of the

administrative block, and a kitchen garden laid out and planted with fruit trees and vegetables.

The whole of the work has been designed and carried out under the supervision of the Author, in conjunction with the late Herbert Littlejohn, M.D., D.P.H., and F. Dittmar, M.D., both medical officers of health for the borough during the period occupied by the work.

The total cost of the completed works, exclusive of site, was 14,785*l.*

Small-pox cases are treated on a separate site on the banks of Scalby Beck, in wood and iron buildings erected by the Author.

Depot.

The highway and sanitary depots are concentrated on the site centrally situated in Cemetery Road, formerly occupied by the borough gaol, which comprises stabling for horses, blacksmiths', painters', masons', and carpenters' shops, stores, storekeeper and yardman's cottages, steam-roller sheds, tar-paving plant, etc.

For a number of years part of the premises were occupied as an infectious diseases hospital, and the Author has recently carried out extensive alterations with a view to the better adaptation of the premises for its purposes.

The alterations are not yet completed, the machinery for stone-breaking, gravel-screening, etc., yet remaining to be installed.

Fire Station.

The need for better provision of means of extinguishing fires which had occupied the attention of the Council for some time, was accentuated in the year 1898 by a disastrous fire in which several lives were lost.

The Author was instructed to prepare plans for a central fire station adapted to the needs of the borough. In company with the chief constable and chairman of the sub-committee he visited a number of towns, and the central fire station in North Marine Road erected at a cost of 3000*l.* was the outcome.

The brigade mainly consists of members of the police force of which the chief constable is the captain.

Prior to the erection of the central station the appliances consisting of an antiquated manual about one hundred years old, two hand fire escapes, and a quantity of leather hose, which were housed in sheds in various parts of the borough.

The brigade is now well equipped with a steamer, hose, fire-escapes, and all latest appliances.

DISCUSSION.

Mr. W. WEAVER: I have pleasure in moving that a vote of thanks be accorded to Mr. Smith for the paper he has prepared for this meeting. The tar paved roadways of Scarborough have always been referred to as specimens calling for our admiration and investigation, and as far as I have seen them they present very great features of interest. It appears to me that the traffic of Scarborough is of a limited description.

Mr. J. S. BRODIE: I beg to second the vote of thanks to Mr. Smith for his paper. The Town Hall we are meeting in to-day was in course of construction the last time I visited Scarborough, and I am very pleased to see it has entirely realised the very able designs Mr. Smith was then carrying out. In regard to the question of tar paving, every surveyor who puts down tar paving turns his face and steps to Scarborough to see the process going on here. I must say that I have not known any other town so uniformly successful as Scarborough with its tar paving. The Author tells us that the materials used are not what might be called ideal, but I think the conditions of having all the materials under his feet, and having no cost to incur except for tar and labour, are entirely ideal. He is to be congratulated upon obtaining such a good result with this material, and he has certainly attained the ideal in the cost he has given. I cannot get near it. The best I have been able to do against the Author's 2*s.* 6*d.* per yard for tar paving 4 inches thick is 3*s.* 2*d.* per yard for 5 inches thick. All my material has to be carried 25 or 30 miles, and the cost of carriage is somewhat heavy. I should like Mr. Smith to supplement the information given in the paper both as to wood paving and basalt lava. I have not tried any basalt lava, but I have seen

some, and I must say the results were not satisfactory. As to the sewers, I take it that they are "combined," and there is no "separate" drainage in Scarborough. It would be of interest to have a little further information as to the sewer outlets. I suppose that the outlets are taken to low water. I should like to know whether any kind of filtration has been adopted at the outlets to prevent the danger of pollution of the foreshore. At Blackpool I am only able to discharge my sewage for three hours out of the twelve. The other nine hours I have to store it up in large tanks. As to the Marine Drive, I had an opportunity of seeing this in progress, and it struck me the work was being carried on in a very creditable manner indeed. I very much regretted to hear later on that there had been a disaster from storms. With regard to storms I always remember a remark of the late Sir John Hawkshaw, who, speaking of sea defence works, said, "I do not think engineers are called upon to fight Providence." I think there is a good deal of truth in that. I cannot help wondering that when you began to make your marine drive you did not make it wider. All seaside towns you will find from time to time have to widen their sea promenades, and if they only had the foresight to make them wider at the beginning, a very great saving in regard to future widenings would have been effected. There is very little difference in the cost of putting a sea wall 150 feet from the cliff instead of 100 feet. We all know that towns like Scarborough do continue to grow and extend, necessitating additional promenading space. With regard to the sea wall, I must say I am not an advocate of the concrete block in building at all. I believe you can build more solidly and more economically in mass than in block work. I know there are many eminent engineers who hold a contrary opinion. Scarborough has consulted many eminent engineers about this work, but if the town council of Scarborough had followed Mr. Smith in this matter and not consulted so many engineers, I think he would have given them a wall which would have stood better than the present wall. As to the contour of the wall the upper part is of an upright form. Anyone who has watched the play of the sea in onshore gales realises that with this form of construction, the waves are bound to be driven over the top of the wall and fall with immense force on the road itself. At Blackpool my sea wall has a very heavy bull-nose, hanging about 27 in. beyond the face of the wall itself

and having an ogee curve of 3 ft. radius. The result of that bull-nose is to throw the heavy seas back on the sea itself, and nothing worse than a shower of thin spray falls on the asphalted road. My new promenade, most of which has been completed for three years, has not cost the ratepayers 6*d.* in repairs, either to the promenade or to the wall proper during that time. In regard to the pleasure grounds, they make Scarborough the beautiful place it is. Scarborough is a town where landscape beauty can be seen and enjoyed at the seaside, and I am sure Mr. Smith and his predecessors have greatly assisted nature in adding beauty to utility, in the recreation grounds. Just a word in regard to the infectious diseases hospital. Mr. Smith will agree with me that committees are often very unsympathetic as regards money spent on an infectious hospital. I have worked the cost out and I take it Mr. Smith has provided twenty-six beds at a cost of 14,756*l.*, equal to 565*l.* per bed. This is a very reasonable cost indeed, and I congratulate the Author and his Corporation upon attaining this result. I speak sympathetically because I have recently added twenty-six beds to my sanatorium, a new laundry, and a new mortuary, disinfector, etc., and it has cost me 500*l.* a bed. An infectious disease hospital recently erected near Blackpool cost about 800*l.* a bed. I should like to know what signalling apparatus you have at the fire station. In Blackpool we have installed the "Gamewell" system of signalling. In America they largely use chemical apparatus for putting out fires. I wish to know if Scarborough is thinking of doing anything in this direction.

COMMUNICATED DISCUSSION.

Mr. T. W. A. HAYWARD: I notice Mr. Smith makes a point of one of the chief features in the laying of tar paved roads being an absolutely dry foundation. Has Mr. Smith had any experience of tar paved roads where the foundation has not been as dry as it should be, and has the damp or wet foundation had any deleterious effect upon the roadway? I should also like to know what, if any, are the charges for stone. I should assume from the paper that this is obtained free of cost.

COMMUNICATED REPLY.

Mr. H. W. SMITH: The low cost of the tar paving in Scarborough was due principally to the fact that there were no railway charges on the raw material, the stone being drawn, as stated in the paper, from the foreshore in the vicinity of the borough from which it is brought by local coblemen at a cost of 6*s*. 9*d*. per ton for limestone and 3*s*. per ton for gravel.

Basaltic lava paving has been laid in Scarborough in several of the principal streets alongside and between the tramway tracks where the gradients are very heavy. It possesses the advantage of affording an excellent foothold for horses and is the least noisy of any of the forms of sett paving in common use, an undoubted advantage in a health resort. The life of the basalt paving where there is heavy traffic, would appear to be rather short.

The creosoted red-wood paving referred to, was laid in all principal streets on the route of the tramways. The blocks are 9 in. by 3 in. by 4 in. and with the light traffic of Scarborough are standing very well.

The sewerage of the borough is discharged at low water mark into the sea at all states of the tide by means of two outfalls, one at Scalby Ness (one mile from the north boundary of the borough), and one at the east pier. The set of the tide carries the sewage clear of both north and south bays. No pumping is necessary, and no complaints have been received of flooding.

I think a width of 60 ft. for the Marine Drive will be amply sufficient for the needs of the borough for many years to come. Should it at any time be necessary to widen, it could easily be done on the landward side by setting back the dyke wall.

I do not agree with Mr. Brodie's remarks as to the cost of the job not being increased by taking the wall further out to sea. As stated in my paper, the foot of the wall generally speaking is situate at about low water mark spring tides and the time available for working at foundations was necessarily very short. Had it been taken further seaward the length of time occupied by the work would have been much increased. The exposed situation of the work rendered the use of divers out of the question.

I do not think the adoption of a bull-nosed coping as suggested by Mr. Brodie would be advisable in such an exposed situation

as this, and am of opinion that it would be lifted off during any one of the gales (accompanied by exceptionally high tides) such as have been experienced recently, and which have caused damage to the works.

With regard to the building of sea walls entirely in mass concrete, whilst I think there are advantages in this method in the construction of sea walls which were situated about high water mark, and only occasionally subjected to the action of the sea, such a system would in the case of the Scarborough Marine Drive sea wall have been entirely out of the question. During the progress of the work despite the protection afforded by the block face, the contractor from time to time lost very considerable quantities of the mass concrete backing.

With respect to the method adopted for signalling to the fire station, each ward in the borough has a fire alarm box and telephone prominently situated communicating with the fire station, and the engineer in charge is in direct communication with those members of the brigade living away from the station by means of electric call bells. There were also two small sub-stations in direct communication with the central station. The brigade is not equipped with a chemical engine.

Dealing with the communication from Mr. Hayward, my experience of tar paved roadways where the foundation is wet is that the paving very rapidly breaks up, and has an exceedingly short life. Where a wet place occurs in a roadway (which is very soon observable by a darkening of the surface of the roadway surrounding it), it is my practice to cut out such portion and to repave the foundation on sand.

The cost of the tar paving is dealt with in my reply to Mr. Brodie.

At the conclusion of the business proceedings, the Members walked to the new Marine Drive to inspect the work in progress. Mr. H. W. Smith, A. M. Inst. C.E., and Mr. Rowntree entertained the Members to luncheon at the Grand Hotel. Subsequently, the Members visited the Corporation Highways depot, a number of tar paved roads, some of which were having the surface repainted, and the fire station in North Marine Road. On the conclusion of the visits, the Members returned to the Town Hall where they were hospitably entertained to tea by the Mayor and Mayoress (Alderman and Mrs. W. Hastings Fowler).

On Saturday, the Members assembled at the Town Hall and proceeded in brakes to visit the Holbeck Gardens and the waterworks pumping station at Ireton, where Mr. W. Millhouse, A. M. Inst. C.E., waterworks engineer, acted as guide to the party. Afterwards the Members drove through the village of Ayton and Forge Valley to the Everley Hotel at Hackness, where luncheon was served.

SCOTTISH DISTRICT MEETING.

June 15 and 16, 1906.

Held in the Town-Hall, Berwick-on-Tweed.

F. G. HOLMES, BURGH SURVEYOR, GOVAN, *in the Chair.*

THE Mayor (Councillor Thompson) received the Members and offered them a hearty welcome to Berwick.

The Chairman returned thanks on behalf of the Association.

SCOTTISH BY-LAWS.

Mr. J. BRYCE: We have had several meetings of the By-Laws Committee since we reported last year. We have had a good many meetings, and now I am glad to say the whole thing is complete and in rough draft. Before we go to the Secretary for Scotland, we think it advisable to get as much light as possible from the Burgh Officials Association of Scotland, which is practically a Town Clerks Association. Then we shall approach the Local Government Board and the Secretary of State for Scotland to get a model set of by-laws published, which would be applicable for the whole of the burghs in Scotland.

THE CHAIRMAN: I think, in the circumstances, we may feel well satisfied with the progress which has been made. I have no doubt in the near future we shall find these by-laws will be ready for operation.

Mr. J. Bryce, of Partick, was unanimously re-elected as Honorary Secretary for the Scottish District.

MUNICIPAL WORKS IN BERWICK-UPON-TWEED.

By R. DICKINSON, Borough Surveyor.

Municipal.

Berwick-upon-Tweed is a borough and county of itself, and includes the parish of Berwick and the townships of Tweedmouth and Spittal. Berwick is situated on the north side of the river, Tweedmouth and Spittal being on the south side.

The Town Council consist of 6 aldermen and 18 councillors, the mayor being elected annually by the members. The Council act in a dual capacity as the Corporation and as the Sanitary Authority.

The functions of the Corporation are mainly confined to the management of the freemen's estate. It also administers the Food and Drugs, Explosives, Cattle Plague, and Education Acts; it exercises control over the police establishment, and on behalf of the Government it is custodian for the old Berwick Bridge. Out of its funds it contributes 320*l.* per annum towards the cleaning and maintenance of Berwick streets. Its officials include the Recorder, Town Clerk, Clerk of the Peace, and Coroner.

The Town Council as the sanitary authority comprise the same members, but with its own officials. It is guided by its own clerk, and its function is to administer the Public Health Acts.

Statistical.

In the following table it will be noted that while the Poor Rate is levied uniformly over the whole borough, the sanitary rates vary in Berwick, Tweedmouth and Spittal. Each part of the borough defrays the cost of its own services. Tweedmouth has neither water nor sewerage, and consequently is not rated for

Divisions of Borough.	Area in Acres.	Population last Census.	Assessable Value.	Amount raised by 1d. per £.	Sanitary Authority Rates. General District.	Special Gen. D.	Poor Rate.	Total Rate.	Outstanding Loans. Sanitary Authority.	Corporation.
			£	£ s. d.	s. d.	d.	s. d.	s. d.	£	£
Berwick	5790	8,279	33,330	138 17 6	1 7	10	3 1	5 6	8,600	—
Tweedmouth ..	833	3,091	10,193	42 9 5	2 0	—	3 1	5 1	—	—
Spittal	306	2,069	6342	26 8 6	3 6	—	3 1	6 7	3,480	—
Whole Borough Establishment	—	—	—	—	—	—	—	—	1,914	7132
Totals ..	6929	13,439	49,865	207 15 5	—	—	3 1	—	13,994	7132

Note.—Special General District rate of 10*d.*, is for sewerage 1*d.*, water 9*d.* Sanitary Authority loan, 1914*l.*, is for offices, stabling, etc., and borehole. Corporation loan, 7132*l.*, is for police establishment and education. The total indebtedness of the borough, 21,126*l.*, works out at 1*l.* 11*s.* 6*d.* per head of the population.

such, while the Spittal rate includes sewerage expenses, but not water, this being paid to the owners of the waterworks. This charge, which varies, may be taken at 1*s.* 6*d.* in the £, so that the total rates in Spittal amount to over 8*s.* in the £ as against 5*s.* 6*d.* in Berwick. Establishment charges, which include salaries, hospital expenses, buildings, etc., cannot be debited to each place according to the service rendered, and are divided in proportion to the rateable values.

The authority has been content to levy out of current rates for permanent improvements rather than borrow for such purposes, and consequently no important improvement schemes are in progress. For years Berwick levied 6*d.* to 8*d.* in the £ for renewing streets, and when the small rate-producing power of each division of the borough is considered, very little can be done even with very high rates. Four causes seem to explain the hitherto deep-rooted objection to the principle of borrowing, viz.: the reckless mismanagement of the old Guild which ruled down to 1835; the misapplication of the principle "pay as you go"; the idea that borrowing is expensive; and the comparative isolation of Berwick from other large and progressive centres.

At last meeting, however, the Berwick rate estimate was reduced 3*d.* in the £ by striking out two items of permanent

improvement, the required sum being ordered to be borrowed. This action may be taken as an indication that a more progressive spirit is beginning to prevail.

Berwick Bridge.

This rare old relic is entirely under the jurisdiction of the Corporation, into whose keeping it was handed by Charles II. together with a perpetual annuity of 100*l.* per annum, for its maintenance.

Built during the years 1611–1624, the bridge is carried on fourteen piers of substantial proportions. The arches are formed of two rings of freestone of a total thickness of 3 ft. 2 in. It is 1000 ft. long, and the carriageway is 13 ft. 3 in. between kerbs, with narrow paths on each side. The foundations and arches are sound, but the piers and cutwaters are not in a satisfactory condition.

The action of the river has had the effect of washing out the joints of the cutwaters, while surface water penetrating downwards between the rubble paving of the old paths and defective channelling, has completely disintegrated the lime concrete with which they have been formed. The Corporation had in view a thorough repair, and instructed Messrs. Read and Waring, of Westminster, to examine and report. The estimated cost of putting the whole bridge into good order was 5430*l.* As this work, however, included taking down and rebuilding the cutwaters and part of the piers, the question developed into one of widening the bridge.

Owing to the increase of heavier and speedier traffic, the narrowness of the bridge has become a serious matter; for while a traction engine is crossing, all other traffic must be stopped. It may be mentioned incidentally that during the early months of this year no less than sixteen traction engines and two motor wagons have been travelling constantly with manure from the factories in Spittal alone, and that there is no other means for them to cross the Tweed nearer than Norham Bridge, which is eight miles distant; and when it is remembered that this is the main route between England and Scotland, carrying a constant stream of motors, the Corporation did well to raise the question of widening. The engineers were consequently instructed to prepare a scheme.

Their proposal is to take down the piers and cutwaters to the level of the brandreths, and rebuild on the same position, re-using the best of the existing old weathered stone for external work, the solid interior to be of Portland cement concrete. When the piers are carried to the necessary heights, it is proposed to spring new arches outside the existing arches on both sides. This part of the work to be executed in ferro-concrete, but faced with old stones, while the existing parapets, which are 13 in. thick, of sound ashlar, will be carefully taken down, and after being reduced three inches in thickness, will be again used. As arranged, the alteration will increase the carriageway to 19 ft., with a 5 ft. path on each side, and as the present structure carries both gas and water mains, provision is made under the paths for this purpose. The estimated cost is 16,000*l*. The scheme was designed to avoid destroying the unique character of the bridge, and in this respect it has received a very hearty approval. As soon as the proposed widening was publicly discussed, the interest in the bridge, from an antiquarian standpoint, became evident. But putting that aside, the multiplicity of interests involved is a serious difficulty to overcome.

The bridge is essentially an Imperial one, having been built and maintained out of the national exchequer; the Corporation is not liable to widen, being simply custodians for the Government; the sanitary authority, though under obligation to provide highway accommodation within the borough, has never had any control over this structure, while the County Council of Northumberland is also involved, as this bridge forms the only highway through this part of the county. Negotiations have been opened with the County Council, and also with H.M. Treasury, where they remain for the present.

Water Supply.

Berwick.—Only the Berwick division of the borough has a public water supply. Originally, this was provided by the Corporation or Guild from certain springs on the freemen's estate, and was conveyed to various public "pants" by means of wooden pipes. In addition, almost every property had a private well.

In 1855, the then local board of health constructed a storage

reservoir of 6½ million gallons capacity on a piece of moorland at New East Farm, about 2½ miles north of the town, at a level of 440 O.D. The water was conveyed to a service reservoir at Castle Terrace, about ¾ mile from the town hall, from which it was distributed throughout the town. Its capacity is 250,000 gallons, and the top water level is 197 ft. O.D. For this work Mr. R. Rawlinson—afterwards Sir Robert—was engineer.

This supply served the purpose until 1870, when the land and springs at the existing Tower Works at Tweedmouth were purchased. These springs yielded 230,000 gallons of water, which flowed daily into the river, over the bottom of what had been a freestone quarry. A reservoir was constructed on the quarry bottom, with three open jointed sides into the bank from which the springs issued. At a lower level a second reservoir was built, which received its supply from the higher reservoir. From the low reservoir the water was pumped to the original Castle Terrace reservoir. For this scheme, Messrs. Leslie and Reid, of Edinburgh, were the engineers.

This new supply was used in conjunction with the older New East Farm supply, and on the lowest estimate formed a daily supply of over 320,000 gallons, for a population of 8000, or 40 gallons per head, and still the demand grew apace.

Before 1890, when the Author was appointed, the supply became totally inadequate, and for some years it was impossible to maintain a constant supply during summer months. At the time, with the exception of lighting and finance, a single works committee managed every other department. So far as water supply was concerned, there was practically no control, no regulations, no meters, no trade charge, no inspection of waste, no required strength of fittings, no application for supplies; in fact, the supply was in the hands of plumbers. To cope with such a chaos single-handed was impossible, and the Author agitated for a special committee charged solely with water business.

After much opposition a water committee was appointed. With a strong man at its head, and grasping the situation, the committee soon justified its existence. A Deacon waste water meter was procured, which told tales that forced the appointment of an inspector. Regulations became imperative; the Water Works Clauses Acts were put in force, and slowly but surely the committee gained ground, and past

anxieties began to disappear. The old New East Farm supply, in consequence of the gradual cultivation of the watershed, had become of doubtful purity, and owing to the prevention of waste, the committee were able in time to abandon this supply altogether. A new pump was provided, capable of delivering 28,000 gallons per hour, instead of the original pump which was only equal to half that duty, and in order to further reduce waste and destruction of fittings, the town was divided into two districts by utilising a small reservoir as a pressure-reducing tank, so that on no part of the mains does the pressure exceed an equivalent to a head of 100 ft.

Charges for trade supplies, which had long been threatened, did not begin to operate till two years ago. This was vigorously opposed within the authority, as well as without, but there could be no going back. It became a choice between the abolition of meters and an additional supply, and the authority accepted the proper alternative. A charge of 1*s.* per 1000 gallons was ordered, and this was shortly afterwards reduced to 8*d.* per 1000 gallons. The revenue derived from this source is only about 350*l.* per annum, partly because no minimum charge has been made for metered supplies. In many cases where supplies are metered, the amount paid for water is less than the meter rent. One hundred meters are in use. The meter used is Kent's "Standard," and its adoption has been fully justified by experience.

Berwick now rejoices in a water supply of over 30 gallons per head, well distributed, and provided with 120 hydrants, but with the serious drawback that it does not reach the highest part of the town containing some of the best residences. This district has its own supply but without "head," and consequently would be at a disadvantage in case of fire.

While much of the difficulty in establishing trade charges has been due to a restricted use of water by means of meters, the system of rating which obtains here is greatly to blame. All property within the special district—whether trade or domestic—is assessed according to its full rateable value for domestic water.

In fixing the charges, both for metered supplies and by scale, the authority had this specifically in view, and the trade water charges are definitely fixed "in addition to the ordinary rate."

While the reorganisation of the water system has been pretty thorough, the bed-rock has not yet been reached, and complete satisfaction can never obtain until some method of differentiation is adopted in the rating of trade and domestic premises.

Tweedmouth.—The supply to Tweedmouth is derived from two sources, a private company and public wells. The company's supply will not rise to a greater elevation than 35 ft. O.D.; and as part of Tweedmouth rises to a height of over 100 ft. O.D., it will at once be seen how partial that supply is. The parts beyond reach of the company's supply get water by carrying it from public wells, in some cases 300 yards distant. For twenty years Tweedmouth has been trying to obtain a supply. Many attempts have been made, and the advice of as many followed, not excluding the rod diviner.

Spittal is in a better position than Tweedmouth for a supply, inasmuch as it is distributed nearly over the township, but it will only rise to a level of about 60 ft. O.D., and consequently there is no building development. It is owned by the trustees of a deceased landowner.

Proposed Combined Water Scheme.

After prolonged investigation, the writer became satisfied that probabilities were greatly in favour of additional water being found on the ground of the Berwick Waterworks, but as boring involved considerable risk from two sources, he advised, as a preliminary, that the advice of an engineer, experienced in work of this nature, should first be obtained. The dangers feared were the possibility of interfering with the existing springs, and of sea water being drawn into the bore-hole, in consequence of its close proximity to the tidal waters of the river.

Geologically, Tweedmouth overlies the carboniferous system, with its alternating series of limestone, sandstone, shale, and coal. Underlying the deepest coal, and stretching from the Tweed to the Cheviots, there is a bed of sandstone 600 ft. to 800 ft. thick, and from this sandstone some of the largest supplies in Northumberland are derived.

The matter was referred to Messrs. Read and Waring, who were engaged in carrying out a similar scheme in Lancashire;

and after careful inquiry on the ground, they confirmed the opinion already given, and recommended that a trial borehole be made to determine the depth of the water-bearing stratum in the first instance, and thereafter to proceed with well-sinking as might be found necessary.

As this borehole was to be sunk on the Berwick Waterworks' property, and as there was a prospect of its being utilised in a borough scheme, the three divisions—Berwick, Tweedmouth, and Spittal—agreed that the work should be carried out at their joint expense. Local Government Board sanction was readily obtained to borrow 500*l*. for the work, and Mr. John Thom, of Patricroft, the selected contractor, commenced operations forthwith. No water was met with until a depth of 282 ft. had been reached, and at 299 ft. the water rose to within 2 ft. 6 in. of the surface. In the expectation of the water overflowing the surface, boring was continued until 413 ft. was reached, but, excepting a 3½ ft. band of sandstone, nothing but clay was penetrated.

The borehole commenced with a diameter of 9 in. for 30 ft., and was gradually reduced to 5 in. diameter in the water-bearing rock. It was lined throughout, but for 40 ft., where the water was found, the tubing was perforated to admit the water. The Local Government Board stipulated, among other things, that the borehole should be tested for a fortnight by continuous pumping, and before this test was begun, the borehole was securely plugged with 50 ft. of milled clay at the bottom.

An air-compressor plant was employed for the test. The water was discharged over a weir 12 in. in length, and on the thirteenth and fourteenth days the flow remained steady, at a depth of $2\frac{7}{16}$ in., being equal to 175,000 gallons per 24 hours. As the surface of the borehole was only 10 ft. above high water, samples of water from it were taken at both states of the tide, and the analyses proved it to be in every way satisfactory. The quantity obtained from so small a bore exceeded the most sanguine expectations, while the existing supply had not been affected in the slightest degree.

The result was deemed so satisfactory that the engineers were instructed to prepare a scheme for the supply of the whole borough. The scheme was to combine the existing supply and that from the borehole, and instead of pumping the water to

Berwick, to pump it to a reservoir to be constructed in Tweedmouth, where a site could be obtained about 100 ft. higher than the Castle Terrace reservoir, which would provide head to gravitate the supply to any part of the borough.

The present pumping main was to be extended, and utilised for delivering water from the new reservoir to the existing Castle Terrace reservoir for the supply of Berwick. As the new reservoir was intended to contain three days' supply for the whole borough, and the Castle Terrace reservoir could only hold one day's supply for Berwick alone, Berwick would be safeguarded against the existing risk of the supply being cut off in case of a machinery breakdown. Separate pipes would convey water to Tweedmouth and Spittal, where it would be properly distributed, and this would have provided, in one establishment, a thoroughly compact and efficient water supply for the whole borough. The authority's instructions were fully complied with, and the estimated cost of the work is 20,000*l.* In January last, at a meeting of 18 out of 24 members, 8 voted for, and 9 voted against the scheme, and one declined to vote. The position to-day is that, on the recommendation of the Spittal representatives, the authority has decided, subject to the approval of the Local Government Board, to purchase, for the use of Spittal alone, the Spittal Waterworks, and the farm on which they are situated, at a cost of 8000*l.* Tweedmouth remains as before, in urgent need of a supply, with no prospect of its acquisition. Berwick is considering a proposal to provide a pump to raise water from the Castle Terrace reservoir, for the supply of Castle Terrace.

SEWERAGE.

The sewerage of Berwick was engineered in 1855, and consists of 9-in. and 12-in. Doulton's stoneware half faucet pipes in 2-ft. lengths, with clay joints, and 2-ft. and 2½-ft. diameter circular sewers of hollow bricks. The necessary manholes and lampholes are of the engineer's well-known type. The sewers are carried through the river wall at about the level of high tide, on the outside of which are provided hinged metal flap-doors. On inside of river wall, chambers are formed by means of which the sewage is collected and carried downwards

in 12-inch metal pipes to the river bed, and discharged into the stream at low-water mark. In this way the flap-doors are only brought into requisition during heavy rains.

No provision was made in the original scheme for ventilation, but about twenty-five years ago 9-in. vertical shafts—some with and some without extractors—were provided, and ten years ago the close manhole covers were removed and open gratings substituted throughout one section. Having been completely sealed for forty years, offensive smells occasionally became very evident, and the authority agreed to a systematic rearrangement of the sewers by which all dead ends were abolished, and the gradients were so altered that by means of seven automatic flushing tanks (fitted with Adams' syphons), up to 1500 gallons capacity, the whole of the sewers are regularly flushed. At certain states of the tide the outlets are tide-locked, but this causes no annoyance.

The Castle Terrace district was sewered about twenty-five years ago, and this is the only extension to the original sewerage system, which indicates the stationary character of the town. It was made a special district and is rated for its own sewerage at 5*d*. in the £. The last payment to clear off the debt on the original scheme will be made this year, which explains the small rate of 1*d*. for sewerage purposes. It may be stated, however, that the greater proportion of the sewers are laid in a natural bed of good stiff clay, and but for that very fortunate circumstance, the system would have had to be renewed long ago. The pipes, however, although they have been buried over fifty years, are as good as new.

Tweedmouth is not sewered, but surface water is conveyed to the river in old conduits and drains.

Spittal, notwithstanding its small rateable value, is now completely sewered, with two outfalls to the river, and instead of requiring water for flushing purposes from the water company, an old conduit at a high level was discovered under a public footpath conveying water from a disused spring. This was at once commandeered for flushing purposes, and for a total sum of 150*l*. produced out of rate, a small collecting tank, distributing pipes, and four flush-tanks were provided, by means of which the whole system is kept sweet.

Streets and Roads.

The whole of Berwick is paved with whinstone, except one street which is of beechwood and one of macadam. For main thoroughfares setts are used, and for secondary streets mashed rubble. Tweedmouth and Spittal streets are mostly macadamised. Northumberland quarries produce a fine quality of whinstone for paving purposes, but long lengths for kerb, etc., have to be got from Ratho district. Setts cost 15*s.* 6*d.* to 17*s.* 6*d.* per ton; mashed rubble, about 12*s.* per ton; setts cover about 3½ sup. yards per ton, and mashed rubble about 4 yards per ton.

Throughout the borough the footpaths are laid with granite-topped cement concrete.

There are twelve miles of main roads within the borough, towards the maintenance of which the county council contributes 91*l.* per mile. Only hand broken metal is used, and is specified to pass a 2¼ in. ring. In sledging the rock into suitable sizes for knapping, breakers are much given to cut carelessly and at random, and generally produce thicknesses of ¾ in. to 1¼ in.; but metal made from this stuff will not carry heavy traffic. Breakers have been urged to take more time and cut up to 2 in. thick for the purpose of getting more cubical metal. Samples of machine-made metal were procured from five different quarries, but none of them could be adopted. They were too round and flaky, while hand-broken metal could be got as cheaply. Metal laid on roads here costs from 8*s.* 6*d.* to 10*s.* per yard.

Public Conveniences.

During the last few years a great improvement has taken place in accommodation of this nature. In addition to the older erections, one for gentlemen, containing three w.c.'s, and nine urinal stalls, and one for ladies, containing three w.c.'s, and lavatory basin, have been provided. The latter is in a very good situation on Bankhill, and is much taken advantage of. Two additional urinals have been ordered for gentlemen.

In Tweedmouth there is one for gentlemen, while Spittal has provided a building on the promenade which combines a convenience for ladies at one end, and for gentlemen at the other. Between the two and under the same roof there is a

covered seat facing the sea, and the space immediately behind the seat forms a shelter from rain. The works are plain, but the interiors are all lined with white enamelled bricks, and the fittings are substantial.

HOSPITALS.

A wooden hospital erected about thirty years ago continues to do duty for infectious diseases. It contains eight beds.

A second hospital on the same enclosed ground was provided for smallpox in 1902, and the finishing touches were just being given to it when the first case occurred. It contains two wards, one with three beds, and one with four beds, nurses' room, scullery, bathroom, and three w.c.'s. The building and furnishing cost 291*l.*

Temporary wooden accommodation for doctor and nurses was erected close at hand. It contains two sitting-rooms, four bedrooms, kitchen, and two bathrooms.

Temporary observation huts were constructed near Spittal. One hut was used only for sleeping in, and accommodated twenty-four suspects. The other was used as a common dining and reading room, and contained in addition, a kitchen, and bedroom for caretaker. The doctor's quarters and huts were built in a hurry, night and day, and cost, including furnishings: doctor's quarters, 241*l.*; observation huts, 272*l.* During 1903 there were eight cases of smallpox and fifteen suspects; and in 1904, nine cases of smallpox and thirty-two suspects. Negotiations are in progress for a site for a new smallpox hospital.

BY-LAWS.

Building by-laws based on the model by-laws are in operation. The by-law relating to air space at the rear is the only one that has caused trouble. Built as Berwick is, huddled together on the yard system, this by-law is essential to prevent the perpetuation of the prevailing congestion. The question of by-laws in relation to cheaper houses of wood and iron, etc., has been raised, and is referred to a committee for consideration.

DISCUSSION.

Mr. J. Lee: Mr. Dickinson, in reference to street improvements, seems to indicate that all the street improvements carried out in Berwick are carried out from revenue. The borrowing of money for the carrying out of street improvements is quite a legitimate charge to put upon the rates. There is no reason why the present generation of ratepayers should pay to carry out improvements to benefit those who are to follow. I am quite of opinion that when any town goes in for extensive street improvements, the cost ought to be raised by loan and the repayment spread over a period of not less than fifty years. The Government is inclined now to reduce the period to thirty years, but where a permanent street widening is carried out the repayment ought to be spread over a period of fifty years. With reference to the water supply, I am a little surprised to find that Berwick has three separate systems of water supply in the borough. I can hardly imagine how it is possible to get a satisfactory administration of the water-supply with three different authorities controlling it. In all cases, such as water-works, gas-works, and similar undertakings, my opinion is that these should be under the control of the municipal authority having charge of the whole borough. Then there are one or two curious things with reference to your rating for water. I notice that you charge for water on the full rateable value for domestic supply, but if any mill or workshop requires a supply by meter they have also to pay for that supply. Well, all I can say is that you are very lucky if you get it. I can tell you that in Paisley we should not get it. We do not charge the domestic rate on the works, but charge a public rate of 1*d.* in the £, and then charge for the water by meter. To charge two rates seems very unfair. There is one statement in the paper which is quite new to me, and of which I should like an explanation. It is stated that "originally water was conveyed to various public pants by means of wooden pipes." I am not very sure what is meant by a pant. I notice that you are going in for a combined water scheme, and I think it would be a very great advantage to Berwick if that could be carried out. I see you are proposing to get that supply from a borehole. I think in every case where it is possible the water should be obtained from a gathering ground and stored in a reservoir.

Boreholes are always very troublesome and sometimes do not act very well.

Mr. P. C. SMITH: I should like the Author of the paper to give us some information as to the meters, and to tell us if he finds the Kent meter as reliable for small quantities as for large. For myself I have found with this meter, and others, a want of accuracy when the consumption is very small.

Mr. J. R. WILSON: I should like to give you some practical experience of several of these small meters. I have tried these meters (not the standard) and find them most unreliable. In one or two cases where we have turned the water on full we could make the meter indicate anything, and in other cases we could make them indicate nothing. Then as to the minimum charge for the water. I think the minimum charge for water supplied by meter should be not less than 2*l.* per annum.

Mr. W. F. CURRY: I should like a little information as to the quantity of water the Author expects to get from this borehole. In South Africa, we want a lot of boreholes, and we have to get the water as best we can. Sometimes we get a good supply, sometimes we do not. The Author might give us information as to whether he expects to get the water from crevices in the rock or from percolation into this borehole, and in what quantity. I think if you can get an adequate supply from a borehole it is far preferable to a gathering ground. With regard to the Kent meters, I remember some years ago trying them and found them fairly accurate. One, however, was fitted which did not register anything, although it was known a large quantity of water was being consumed. For a time we could not find out what was the matter, but on examination it was found that the workmen had put the supply pipe on the exhaust, and consequently the meter was not working.

Mr. T. NISBET: With regard to the sewerage, I notice that the town was sewered in 1855 and that half-faucet pipes have been used, with clay joints. Mr. Dickinson says this method of laying the sewers has been successful, and attributes the success to their being laid in a good natural bed of stiff clay. In Glasgow pipes laid with clay joints have been very unsuccessful, as the clay soon gets washed out of the joints, and a subsidence of the surface generally follows.

Mr. G. LANDALE: The section in the 1903 Act relating to open space attached to dwelling houses is framed to read as if

every dwelling house which is to be built must face a street, because it refers to the building fronting the street, and provides for the open space behind it. If a man has a piece of land extending to a great depth from the back of his property in excess of the requirements, he is evidently debarred from employing this land for building dwelling houses. Under the Act of 1892, the area in rear for the ventilation of dwelling houses had to be three-fourths of the space occupied by the buildings.

Mr. C. BROWN: Our supply of water at Hawick is very different from Berwick. We have a good supply, and have very little to do with meters; in fact we have so much water that we run some of it down the channels of the streets in the summer time. Along the whole length of the street a 1-in. diameter pipe is fitted into the channel at intervals of about 100 yards, this pipe is connected to the water mains, and in hot weather the water runs the whole day. It helps to cool the street, and is very much appreciated by the Hawick people. Another great use this pipe fulfils, viz., on the streets being swept by the sweeping machine the whole of the mud is carried away by surface drains into the river. In this way the macadamised roads can be swept every day without having any mud to deal with.

Mr. A. H. GOUDIE: As to charging by meter, and charging a public rate as well, we are at Stirling pretty much in the same position as Paisley. We charge a penny rate for domestic supply in cases where the supply is by meter. Having three different water supplies must cause a good deal of trouble to the engineer, and cannot in any way be satisfactory. As to sewerage pipes jointed with clay, my burgh, which is an old one, has a good many of the old sewers which have been jointed with clay. The burgh is built partly on rock and partly on clay, and in dry weather the clay cracks to a considerable depth, and where the sewers are shallow they leak. In several cases we have relaid the sewers.

Mr J. LEE: With reference to the infectious diseases hospital, the Author does not say how the second hospital has been constructed. He refers to the first hospital having been constructed of wood thirty years ago. I was wondering if the authorities allowed him to construct a wooden hospital again in 1902. I was rather suprised: I thought the Local Government Board objected to that kind of thing, at any rate, they do not encourage it.

Mr. J. R. WILSON: We have an infectious diseases hospital

in Helensburgh, and in another field not more than twenty yards away from it we have erected a small-pox hospital.

The CHAIRMAN: It would be quite fenced off, and distinct from the grounds of the other hospital?

Mr. WILSON: It is fenced off with a hedge.

Mr. J. BRYCE: Mr. Dickinson has given us a very clear statement of municipal affairs in Berwick, and certainly to those of us who are accustomed to supervision on a large scale, and by one body, it is very surprising to find that a town a thousand years old has got this old-fashioned system of rating, with parts of the borough like independent colonies, evidently more or less rebellious, and desiring to be rated according to their own peculiar ideas and views of things. I think local prejudice has entered to some extent into all this division of opinion. For instance, take the proposal of Spittal to spend 8000*l.* on a water scheme for themselves. I wonder if the Spittal ratepayers really know what that means to them, because I see from the tabulated statement in the paper that a penny rate only raises 26*l.* The population of Spittal is given as 2000 out of a total of 13,000. It would seem perfectly reasonable and fair that the three divisions of the borough should combine in one grand scheme and have one uniform rate of assessment. It would certainly make things much easier, would be more economical to the ratepayers, and better for the town. With regard to public improvements, when the prejudice against borrowing has been got rid of, money might be raised by loan to beautify the place and make it a pleasure resort. Other towns both north and south, have spent money on their development as health resorts. Dunoon is following Blackpool in that respect. Dunoon, which is a small place on the Clyde, has spent 40,000*l.* in trying to beautify the place, and I heard that the debt was going to be wiped off with a rate of 3*d.* or 4*d.* in the £, spread over a number of years. I do not know how this is going to be done, but that was what I heard. I should like to ask as to the cost of the seven automatic flushing tanks on the sewerage system, the cost for water and repairs, how often they are flushed, and if they are found satisfactory in improving the ventilation, with the result that upcast shafts are not required? My own opinion is that if sewers are well flushed and ventilated in the ordinary way in streets with grids at the surface, there is no need to resort to upcast shafts in order to get rid of objectionable smells.

The CHAIRMAN: Before calling upon the Author to reply, I would like to say we are very fortunate in having a paper which has aroused so much interest. This is the first Scottish meeting at which any paper has aroused the same amount of discussion. I see you have a very large area in Berwick compared with your population. The population is something like 13,439, and for that population you have an area of 6929 acres—that is to say, two people to the acre. I wish we could match that in Govan. We have 69 people to the acre, and the surrounding districts are as populous. The question of separate differential rating is an important one. Tweedmouth has neither public water supply nor sewerage, and yet it forms part of a large town. Now that is not satisfactory. If differential rating was got rid of, that could be remedied, because the cost of sewers and water supply would not be so serious as if each district had to provide them for themselves. I do not think Berwick would be injured, because it is in the centre of a most beautiful country, and if people are brought to Tweedmouth they also come to Berwick. Spittal seems to be well provided for in the matter of sewerage, but I see that the water supply is in the hands of a private company. I do not think that water or gas in the hands of private individuals is at all satisfactory, and the sooner the Berwick Corporation purchase those waterworks the better. Then as to borrowing money for carrying out improvements, I do not think there is any need to hesitate. Money can be borrowed at a fairly cheap rate when there is the assessment of the borough as security. I think the Berwick Corporation would be well advised to give serious consideration to the idea of carrying out improvements by borrowing and creating capital charges, instead of imposing undue burdens on the present day ratepayers. I think it right that the ratepayer of the future should be made to pay his proportions of that which will be of benefit to him. Berwick Bridge is one of the most historic structures in the district. I do not think that it is proposed to make it as wide as it ought to be. The carriageway of 19 ft. may be sufficient, but I think the proposed footpath of 5 ft. on each side is much too narrow. If the district of Tweedmouth develops to any extent, there is bound to be a good deal of traffic over the bridge, and I consider there should be not less than an 8 ft. footway on each side. It is my misfortune to have a good deal of trouble with sewers jointed with clay. In Govan the sewers

are not so old as those at Berwick, but many of them are old enough to have been jointed with clay, and it is found that the clay gets washed out not only in the main sewers, but in the side drains, and it is a common occurrence for our men to be called out in the middle of the night to deal with subsidences caused by leakage from the sewers. These in many cases were laid in a sandy soil, which makes it much more dangerous than in other soils. If the wooden hospital has been in existence for thirty years, I think the sooner it is set fire to the better. With reference to infectious diseases hospitals, my town has its small-pox hospital in the same grounds as the other hospital, but there are several acres of land attached to them. All the Local Government Board requires is that we should have it completely clear of the other buildings and completely isolated by proper fencing, so when there are cases of small-pox in the hospital these are completely shut off from the other infectious cases.

The vote of thanks was unanimously accorded.

Mr. R. Dickinson, in reply, said: I am very much obliged to you for the attention you have given to the paper. Mr. Lee favours a gathering ground in preference to a borehole. I do not agree with him there. A borehole water may be defective, but it all depends upon the geological formation of the surrounding country. Underlying Berwick, we have the thick fell sandstone stretching westward to the Cheviot Hills, which is the source of our water supply. It flows from the upper beds of the sandstone, and it is a remarkable fact that no variation in the yield has ever been observed, although it has been regularly tested winter and summer for years. The borehole was sunk into the lowest beds of the sandstone 300 ft. below the present supply. The bore was put down on trial, with the expectation that it would be necessary to sink a well and drive headings, and it was very gratifying to find a 5-in. borehole yield nearly 200,000 gallons in twenty-four hours, for that, in addition to our present supply, will be sufficient for the town for years to come. Unfortunately the joint scheme was thrown out for the present by one vote in the council. With regard to the meters, I have no practical experience of any other meters than the Kent. The meters have been in use for two and a half years, and there have only been two which failed to register very small quantities. So far as my experience goes, the meters have been exceedingly satisfactory. I may remind Mr. Goudie this is an English borough, and Scotland

is to be congratulated on the very great advantages it has over England in regard to its Public Health and Water Acts. The air space in the rear of houses is the only by-law which has given us serious trouble. In some of our yards the houses are so closely built in rows, that occupiers in one row can join hands with the occupiers in another row. If we allowed these houses to be rebuilt, there would be no hope of rooting out this congestion, and the council has steadily refused to allow rebuilding without the requisite air space. Though the area of the borough is large, it is mostly agricultural land, and the population is crowded upon 700 acres. I agree with Mr. Wilson that there should be a minimum rent for water supplied by meter, and have been agitating for that. I know where water is being stolen by means of hose attached to unmetered supplies, and a minimum charge would check that to some extent. Of course, we have our remedy, but it takes some courage to prosecute when the charge would come under criminal law. As to the automatic flushing tanks, the cost of maintenance is practically nil, and we have not arrived at that stage of perfection when we charge one department for the water consumed by another department. Until 1835 the government of the town was in the hands of the Freemen. A certain number formed what was termed "The Guild." They had the power of levying assessments, and had everything their own way. They had power to borrow on the landed estate for their own private purposes, and things had got to such a pitch that when the Reform Bill was passed they had a debt of 48,000*l.* on the estate. In my opinion that is the cause of the prejudice against borrowing, and its effect is seen in the backwardness of the town. Instead of taking a broad view and borrowing money for substantial improvements, we have been doing little by little out of rate, a method by which no progress can be made. As to the infectious diseases hospital, the difficulty has been got over by not going to the Local Government Board at all.

THE PLAN AND REGISTER OF STREETS AS PROVIDED FOR IN THE BURGH POLICE (SCOTLAND) ACT, 1903; THE ADVANTAGES WHICH THEY CONFER, THE DIFFICULTIES WHICH THEY ENTAIL ON SMALLER BURGHS IN OBTAINING A PLAN OF AN ADEQUATE SCALE, AND THE INFORMATION WHICH THE REGISTER MIGHT CONTAIN.

By AND. H. GOUDIE,

BURGH SURVEYOR, STIRLING.

THE duty is imposed on Town Councils by Section (5) of the Burgh Police (Scotland) Act, 1903, to provide a Plan and Register of Streets, in which certain information is to be given as described in that section.

To properly carry out this requirement involves either a great deal of expense on the part of the Town Councils, or a great amount of labour by their surveyors, but the advantages to be derived seem to warrant this expense of either money or labour.

SOME ADVANTAGES OF THE PLAN.

With regard to the plan, the principal advantage will be a fixed centre line on every street which will form a datum from which all measurements of street widenings will be taken. Further, the plan will remain a permanent record of the streets of the Burgh at the date when the plan is made, and of all the various street improvements which may take place from time to time. At present, on a building being taken down for the purpose of re-erection, or on a new building being erected fronting a road or street formerly a turnpike road, then by the Roads and Bridges Act, 1878, the new building must not be erected within twenty-five feet of the centre of the road. Suppose several such buildings have been erected on one side of such road, then if a few years afterwards it is proposed to take down a building on the opposite side of the road, the difficulty at

once crops up of fixing the centre line, but by the method proposed in the before-mentioned section of the Act no such difficulty can arise in the future. Similarly, the fixing of the centre line on the plan prevents any question arising in regard to the operation of section 61 (5) of the Act of 1903, which provides that, where for a continuous distance of 200 yards or upwards there abuts on a street, ground either unbuilt on or not occupied within the thirty foot line by buildings of a greater height than fifteen feet, it shall not be lawful to erect any new building thereon within the said thirty foot line. It is also of immense advantage to a surveyor to have a plan with such fixed line always at hand, so that immediately on a plan of a new building being presented, by consulting the Plan of Streets he is at once in a position to advise his Council whether any alteration of the line of street should be made. This advantage, of course, can only be obtained where the plan is drawn to a sufficiently large scale to allow of accurate measurements being taken; and therein lie the difficulties to which the smaller burghs are subject.

The Difficulties of Smaller Burghs.

In the case of the majority of larger burghs the ten feet Ordnance Maps have been revised. Thus the surveyors of those burghs are in the happy position of having a plan of the streets drawn to an adequate scale ready to their hand. But some of the larger burghs and all the smaller ones are in a less enviable position, the only lately revised plan being the twenty-five inch, a scale quite inadequate for the purposes before mentioned. The reason the Government had for not extending the revised survey of the ten feet scale to all the burghs in Scotland was probably a financial one, but why the larger burghs should be favoured and the smaller ones neglected seems to be an anomaly, as the larger burghs being more wealthy are in a much better position to bear the expense of providing such a plan for themselves. The difficulty being there, the surveyors of the smaller burghs have just to make the best of it, and either be content with the twenty-five inch scale plan, or endeavour to procure a larger scale plan as best they may. To attempt to make the twenty-five inch plan serve the purpose can only be an evasion of the spirit of the Act for which the Author is sorry to say the

letter of the Act leaves the way open. A street plan drawn to such a scale can be of very little practical use for the purpose intended. If the Government could not see their way to provide a plan drawn to a sufficient scale, it might have been desirable had the Act of 1903 made it imperative on all burghs having a population of say 5000 and over, to provide a plan on an adequate scale, a minimum being specified. The expense might have been heavy, but at any rate definite advantages would have been gained, and all burghs above the stated population would have been placed on the same level.

Should the surveyor make up his mind that only the plan drawn to the larger scale will satisfactorily fulfil the requirements of the Act, and at the same time consider that the advantages of such a plan to the burgh which he represents will be of such a practical nature as to be really worth striving for, then only two courses seem to lie open to him, either to prevail on his Council to be at the expense of employing the Ordnance Survey Department in the making of such a plan, or to make the plan himself. Happy is the man who is in the position of serving a Council which has the wisdom to see the advantages to be derived from such a plan, and the courage to face the expense of procuring it in a proper manner.

Let us suppose that the surveyor recognises the advantages to be gained by this large scale plan, but cannot prevail upon his Council to bear the expense, then he must turn his mind to discovering the best way out of the difficulty. He would probably see at the outset that to make a complete survey of the burgh was beyond his powers, or at least that the time at his disposal would be quite insufficient for this purpose. He should, in that case, content himself with making a skeleton plan of the burgh, only showing sufficient for the purposes required by the Act, and at the same time providing him with most of the advantages before mentioned. What is absolutely necessary to be shown seems to be, the line of the street, the building line so far as the buildings are not erected on that line, the division line of every separate property, the line of the kerb, and any other special feature which the surveyor might consider advisable to put in, such as underground conveniences, island crossing places, or ornamental plots in the centre of streets or squares. The plan ought to show clearly the existing state of matters at the date of its completion, to show the actual facts as distinguished from

any intended changes, and in this way to constitute an absolute record to be received beyond any doubt as evidence in questions that may arise in future years. A skeleton plan such as that indicated could show these essentials quite as well as a fuller plan, although for the surveyor's own convenience the fuller plan would be much preferable. As the getting up of this plan in the surveyor's spare time will mean that it will be a labour of long duration, probably extending over several years, he will at any rate be able to console himself that no definite time has been fixed for its completion. The framers of the Act, no doubt understanding pretty well that they were imposing a very heavy obligation on Town Councils, without having provided any means for its accomplishment, left the completion in such vague terms as "that it shall be finished on or before the first day of October in the year nineteen hundred and four, or as soon as conveniently may be thereafter."

The Register of Streets.

The Register, again, should be of immense advantage, although it will entail an enormous amount of labour. Like the plan, a definite time for the completion has not been fixed, thus allowing the surveyor to complete it in his spare time, if not otherwise obtaining special assistance from the Council for this work. The Act gives definite instructions as to the information which the Register must contain, and this is more fully detailed by Mr. Muirhead in the specimen form given by him in his volume on the 1903 Act. This form is very well arranged, and should furnish all the necessary information required for the proper administration of most burghs; although Town Councils may prescribe other particulars not affecting rights of property which they may think necessary or suitable.

1. The first thing to be inserted is the name of the street. This is defined by the 1892 Act, "shall include any road, highway, bridge, quay, lane, square, court, alley, close, wynd, vennel, thoroughfare, and public passage or other place within the Burgh used either by carts or foot passengers, and not being or forming part of any harbour, railway, or canal station, depot, wharf, towing path or bank." This definition is very comprehensive, and when the naming of those places is fully carried out it

should be a great improvement on the present state of affairs in most burghs, where a great many by-lanes and passages are without any recognised name, and the surveyor has difficulty in describing any such place when any alteration, improvement, or other work is being carried out there. The police must also many times have their ingenuity taxed to locate the place without a name where some crime has been committed. In some burghs there are likely to be a great many such places, and in making up the list the surveyor would probably find it advantageous to suggest to the Council the names to be given. On this point, however, he may probably find a number of councillors anxious to have a say, but the surveyor's suggestion will form a useful guide. In the Author's opinion it is preferable to preserve in the names of streets old local place-names or interesting associations, rather than to invent brand-new names with no local significance. This will also be found to be a most suitable time for correcting any anomalies in street names which exist at present, such as streets having different names for each side, streets in the same line having different names for very short lengths, and special names for rows of houses on one side of the street only, where the owner wants to give his property a high-sounding name. All these cases are very confusing to strangers. If a special name for a row of houses is allowed to remain, it should only be as a sub-name, the row still remaining in or part of the street.

2. Next is the situation by reference to numbers or other marks on the plan. By this the framers of the Act seem to have intended the plan to be divided into separate sheets, and the number or marks on the sheet or sheets on which the street mentioned is shown, are to be given in the Register as a reference for the finding of the said street on that plan. This will form an important part of the Register.

3. Then the point of commencement and termination is to be described. This should not be a difficult matter, although in some cases it may require a little consideration. It will be of some value, as the commencement and termination of any street will be at a fixed point clearly described in the Register, thus enabling the Surveyor to know definitely, in making up his yearly expenditure, how much is chargeable against each separate street. In the case of the Town Council executing the work of macadamising or paving any private street for the

purpose of its being taken over, there can be no dispute as to where this street should terminate, and the information will also be valuable when the Council is temporarily repairing any private street at the expense of the frontagers. Again, where two streets in the same continuous line meet, there should be no overlapping of one side of the street over the other, as is sometimes the case at present.

4. The next point is the width of the street and the position of the centre line. In few streets will this be able to be given definitely in figures throughout the whole of its length. They can only be described as the width and position of centre line at certain defined points on the given streets; for all other information reference would have to be made to the plan.

5. Then comes the character, whether an ordinary street, a highway under the Roads and Bridges (Scotland) Act 1878, a lane, or a court, and whether public or private, or of any other character or description. This is a most important clause, and will be of immense value, as it will definitely settle a great many difficult points which are continually cropping up, especially in the older burghs. There will be considerable difficulty and research entailed in procuring exact information as to the character of many of the older streets and roads. Firstly there will be the old turnpike and statute labour roads, a list of which will be in possession of most burghs, as the list would most probably be furnished by the old road trustees, when those roads were handed over to the Town Councils under the Roads and Bridges (Scotland) Act 1878. If this list is not in the possession of the burgh, then it will mean a search in the old road trustees' books if such can be obtained, or taking whatever evidence is available. This will have to be undertaken with some care, as it is most important that this class of road should be clearly defined, both for the powers conferred by the Roads and Bridges Act with regard to widening, and also for the purpose of obtaining a proper share of the Government grant. Then, second in importance will come the old burgh roads and streets, again entailing careful investigation, and probably much research through the old burgh records before the desired information is forthcoming. Thirdly, there will be the streets which have been put in repair and taken over by the Town Council. This information should not be difficult to obtain, as it will be of a much more recent date, and in most cases will be

found in the past minutes of the Council. Along with this class of street will probably have to be placed the streets of which no record of their having been taken over can be found, but which have in all likelihood just dropped in to be maintained by the Town Council through a desire on the part of some former Council to have all the roads put into a half-decent state of repair, and their finding that the easiest way was just to do the work at their own expense. This conclusion would be more readily come to as the expense at that time in all probability would be small owing to the lightness of the traffic. Lastly, there are the streets which have not been taken over, and which are still maintained by the owners or frontagers. This is the class of street which the surveyor will have most difficulty with, as there will be a desire on the part of those responsible for the upkeep of such streets to get rid of this responsibility if possible. Failing their being able to establish a good case for being relieved of this upkeep, then there can in future be no dubiety in the matter, as this will be all properly recorded in the Register. Another class of private street in some old burghs is those in which some old burgh right or privilege is involved, but as those streets will in all probability be maintained out of the common good, no difficulty need arise about their upkeep.

6. The next thing required under the Act is "any other particulars not affecting rights of property which the Town Council may prescribe." Under this heading will come in the various extra items suggested by Mr Muirhead. The information to be given under those headings would certainly be very valuable, and any surveyor might seriously consider the advisability of writing up his Register on the lines suggested by Mr. Muirhead. This will certainly mean a lot of work, but the advantages to be afterwards obtained will more than compensate him, and he will leave a record of great value to his successor. One surveyor may prefer to show such things as the lines of sewers, water mains, gas pipes, electric and telephone cables, etc., on his plan. This is probably the better and easier method where such pipes or cables have been laid by himself, or where a proper plan and section has been left by his predecessor, but in the case of old sewers and water pipes which he has only seen at odd points in the streets, the Register is probably the safest place for this kind of information.

The recording of temporary repairs on private streets would

also be valuable where this had been ordered by the Town Council, as it would at once show when the last repair had been carried out and under what conditions. Most feuars seem to imagine that if they have once paid for any repair upon a street, which has been ordered by and carried out by the Town Council, they are exempt from all future payments for the same purpose, and protest strongly when again called upon, that they understand that the street was taken over when they paid for the last repair. In future, this contention will be untenable, as the entries in the Register will be held as legal evidence of the actual position of every street. Again, the same thing applies to the taking over of pavements. Although in some burghs a record is kept at present detailing all the pavements or parts of pavements which have been taken over, still that does not definitely settle the matter, whereas an entry in the Register would, and that is what makes the Register, if properly filled up, of so much value.

The remarks and opinions which the Author has expressed in the foregoing paper will not apply to all burghs, but Members will be able to judge for themselves to what extent the burgh they represent will be benefited by the Plan and Register of Streets, and how far these remarks apply to their special cases. In drawing up this paper, the Author has tried to make his remarks as general as possible, so as to cover the majority especially of the smaller burghs, and to give some idea to Members of the magnitude of the work which they are expected to carry out, but at the same time to show the advantages which they and the burghs they represent would derive from the information which would be contained in this Plan and Register of Streets, and he trusts that this paper may be of some little benefit to his fellow Members. The Author should, perhaps, apologise to the English Members for submitting a paper of such a purely Scottish character; but the possibility is that if they do not at present possess such a record of burgh affairs they may agitate for such powers being granted to the English boroughs. In that case they should profit by our misfortune, and see that in any powers obtained provision is made for having the work properly carried out, and that no undue amount of work and responsibility is placed on the shoulders of the burgh surveyor.

DISCUSSION.

Mr. T. NISBET: I came here to get some information, as I do not know anything of the register which is to be prepared under the Burgh Police Act of 1903. A register has been prepared in Glasgow under a local Act, with the result that there are five thousand or six thousand law actions entered against me as registrar. I was looking into the question of the origin of the clauses in the Burgh Police Act dealing with the question of a street register and plan, and find that these are pretty much the same as are contained in the local building regulation Act obtained by Glasgow. This again was copied from a bill which was lodged in Parliament by the local authority of Paisley in 1899, but with certain variations. It is noted on the margin of that bill again, that it is founded on the Glasgow local police Act of 1866. In the Act of 1866, there is no provision for removing the name of a street from the register, once it had been entered thereon, with the result that many streets which have ceased to exist as streets many years ago are still on the register. Further, although streets are entered upon the register, if they are afterwards extended, the extension is held by the court to be also a street reparable by the local authority, because that register only refers to public streets. The 1903 Burgh Police Act, however, provides for a register not only of public streets, but also of private streets, and therein differs from the register prepared for Glasgow. Another difference between the register to be prepared under the Burgh Police Act and the Glasgow local Act is that in the former, the centre line of the street requires to be shown, whereas in the latter there is no provision for that being done, and accordingly it is not done. Incidentally, in the course of an action in the Dean of Guild Court in Glasgow, for a warrant to erect a building, the centre line was required to be fixed, and the Court of Session subsequently held that the centre line to be fixed must be the medial line between the buildings as they existed at the date of the completion of the register, even although the street had formerly been widened on one side only. In the view of the Corporation of Glasgow, that is an injustice to the proprietors who have already widened the street on one side, and is giving an unfair advantage to the proprietors on the opposite

side of the street. That is the principal question that has to be settled by the House of Lords in the pending actions. To illustrate the difficulty to the court, I prepared a plan of a street called West Muir Street, where recently a large number of buildings have been erected at different parts of the street. These buildings are set back beyond the old side of the road to the proper building line of the street: the result is that, at the present moment, the new buildings, and the old ones not yet removed, are in an extremely irregular line. Some of the old buildings project beyond the line of new buildings on the one side of the street and also on the other side, the new buildings on the one side not being opposite the new buildings on the other side. The effect, therefore of the judgment of the Court of Session, that the centre line of the street is to be the medial line between existing buildings is that that line is an extremely crooked and irregular line. It is not continuous, but in some cases breaks to the extent of a considerable number of feet, and if the judgment of the Court is to be sustained, that irregular line will be perpetuated, with extremely unsatisfactory results from a public point of a view. Whether that is a difficulty which is going to arise under the Burgh Police Act, I do not know. Again, there are certain streets built on one side only. the other side being an open field. How is the width going to be registered for such streets ? Mr. Goudie has pretty well dealt with the advisability and advantages of a street register. We are all agreed that a street register and plan are very valuable. I notice that certain things must be done after the register has been formed—that is to say, all changes have to be entered, but how can that be done. I do not know whether any burghs in Scotland have completed their registers, if so, I should be glad to hear something about them. Mr. Goudie assumes that if a centre line has been fixed, everybody will have to go back a certain distance from the centre. In Glasgow, we are afraid that the judgment in the case of the register, may repeal the provision of the Acts compelling people to go back a certain distance from the centre line.

Mr. J. LEE: With reference to some remarks which Mr. Nisbet has made as to this register of streets: in Paisley our Act provides that the register and street plan are to be prepared showing the width of the street and the centre-line. In fixing the centre-line, consideration has to be given to the line of the street as originally laid out—that is to say that where a few properties

have been set back, the centre-line is not fixed between the new property and the old property on the other side, but is fixed on the old basis. I am quite sure that is the proper method to go on. A number of the proprietors who came to examine the register and plan took no exception to it, although one or two of them discussed the point Mr. Nisbet has referred to. They seemed to think it the correct thing to do and quite reasonable. With reference to new buildings being put up and one half of the street formed, I do not think the authority would allow buildings to go up until the street had been lined and the centre-line fixed, by the Dean of Guild Court. In Paisley we never allow new buildings to be started until the street has been lined to its full width, and the levels fixed. With reference to the alterations of the register, the register has been altered once or twice as provided for under the Act.

Mr. T. NISBET: I was not dealing with alterations of the register under the 1900 Act, but the 1866 Act, under which there was no power to alter.

Mr. J. LEE: I think the authorities will find this register a very great advantage indeed in deciding the amount of ground to be taken off any proprietor for the purpose of street widening. We take the centre-line, and the buildings must be 25 ft. from the centre. The Act gives you power to put a building back, but it does not give you power to confiscate the land. You have got to pay for that. A case occurred some years ago. A builder proposed to erect a tenement on the old line of street, but the Corporation said he must go back 25 ft. from the centre. He said, "I will go back, but shall keep up my parapet wall." We wanted the ground, and we had to pay for it. If the Act specified that the ground was to be thrown into the street it would save a good deal of money to the public and be very little loss to the proprietors.

Mr. G. LANDALE: I think Mr. Goudie is to be congratulated upon his paper. The difficulty is really not with new streets but with old streets, which were never laid out, but have simply grown. There is one part of the High Street in Musselburgh, which suddenly widens out to 50 ft. wider than the other part of the street. Where is the centre-line to be fixed there?

Mr. C. YOUNG: We have a street 50 ft. wide for a certain length, and then it narrows down to 40 ft. Can the town council fix the building line 25 ft. from the centre and come to

arrangements with the proprietors of the land to widen the street all through, or must the centre-line be fixed at 20 ft. for part of the street, and 25 ft. for the other part ?

Mr. P. C. SMITH : I am of opinion that where the 25-in. ordnance map is used, the purpose of the Act cannot be adequately fulfilled, as the scale is not such that widths of streets and the like can be taken from the plan with any degree of accuracy. To my mind it is a great pity the Government did not see their way to issue a map of the whole of the towns in Scotland with a population of, say, over 5000 on the larger or 10-ft. scale. I am aware that in a number of burghs, the town councils have procured the sheets of the 1864 survey on the 10-ft. scale, and brought them up to date. This has been the case in my own burgh, and the work has been done at considerable expense: consequently, on the score of expense, small communities cannot be blamed for using the smaller scale survey. There seems to be considerable diversity of opinion, and, like other speakers, I am confronted with the difficulty of fixing the centre line in old thoroughfares where the width of the street varies considerably throughout its length; but I presume it is by facing these difficulties and laying down a law for the worst cases that the way to the solution lies.

Mr. J. B. PATERSON : The Act requires the marking of the width and position of the centre line. It does not give any very extensive power to make improvements in the lines of old streets. It allows the approximate centre line to be taken or the centre line of the street as originally laid out. In the case of old streets it is not always possible to tell this, and we must just take them as they are. If any improvements are to be made to the building line, they cannot be made under this Act. The Act requires the width of street to be marked (not width between buildings), and I take it that there is nothing to prevent buildings being erected at present parapet lines unless the adjoining proprietors are entitled to object, or unless the length of roadway unbuilt on exceeds 200 yards. It seems to me that if a literal reading of the clause were taken, as it probably would be in the law courts, the centre line would in many cases be a zig-zag line along the centre of the roadway as used by the public.

Mr. J. BRYCE : I should like to add a little to the discussion on this very important matter. The whole thing is divided into

two points of difficulty, the plan difficulty and the difficulty of the register. It seems to me that the value of the centre line is somewhat exaggerated, because it is literally of no value in regard to old roads where you have no proper building line. It can only be a line put down as near as possible to the centre, i.e. the average through a certain number of zig-zags. I think it would be perfectly legitimate for us officials to refuse to put down a centre line on public highways. In some streets in the burgh I represent it is almost impossible to put down a centre line on the old turnpike highways where buildings have been planted without any rule or guidance in the long past. You can only hope for these lines to be remedied by mutual negotiations, but as to the Law Courts forcing the thing by the fixing of a centre line, I see great difficulty. As to the register, it is practically impossible to register the whole of a centre line in a book and describe it, because there is a column in which you have to fix and define the position of the centre line or the width of the street from the centre line. You can only do that at one or two places. In these old highways, the building line is irregular in many cases. The genesis of this register required by the new Act has been a development from the old Act which simply required a list or record of streets of different classes. I have found this list to be of some value. In a recent case of extraordinary traffic, the list of streets, and whether they were statute roads or highways, was most valuable. I can see the value of a proper list or register of streets which is simply a register of the different classes of streets. Even with the largest ordnance scale, 10 ft. to the mile, it is almost impossible to show the whole network of pipes and cables in a street. You cannot do it.

Mr. T. Nisbet: In Glasgow we are not bound to fix the centre line, we cannot do it; but whenever an application comes before the courts, I am bound to fix the centre. This judgment in the Court of Session binds me down to fix the centre line in the medial lines between the buildings.

The Chairman: With regard to the decision of the Court of Session, it seems somewhat strange. If you take the case of a highway where people have set back 25 ft. from the centre, under the Roads and Bridges Act, and someone wants to build on the opposite side of the road, it would be unfair and illegal to fix a new centre. If the courts hold differently, either the law

is, as in many cases it has proved itself, "an ass," or we do not understand the Act. I think Mr. Nisbet is perfectly right in adopting the old centre. I do not see how you are entitled to play fast and loose with the centre lines of roads. With regard to the difficulties of small burghs, I do not understand why the Ordnance Survey Department go to the expense of preparing the large scale of 10 ft. to the mile for the large towns and not for the small ones. I remember circulars were sent out to the small burghs, asking if they would pay part of the expense of preparing the survey maps on the large scale, which seemed rather iniquitous.

Mr. A. H. Goudie, in reply, said: The principal difficulty seems to be that of the centre line. I do not think Mr. Nisbet has explained the decision in his case. Everybody holds the same opinion as Mr. Nisbet that the original line is the one which ought to be adhered to. I do not think anything further can be added to that. This plan will now settle that matter. If this plan is passed by the Sheriff, with the centre line marked, then if any widening takes place in future, this difficulty will not crop up again. It was very interesting to hear that Mr. Nisbet first got the register of plans from Paisley. It brings up an old story again. I was rather surprised to hear that private streets are not included. It would certainly be an advantage to have private streets defined in this register. A question has been raised about the difficulty of entering the width of the street in the register. Well, it can only be defined at certain points, and then the plan must be referred to—there is no other way. With regard to Mr. Wilson's suggestions as to the plans being prepared in wards, the suggestion as to the plans being on numbered sheets is only in cases where the plan is on the larger scale. It would be too large a plan not to have it divided into sections. With regard to Mr. Paterson's suggestion that we are tied down to the present building line, I do not see it. You have power to widen any street, but you have to pay compensation: you are bound to do that. The other point raised was as to parapets. If they removed the parapet they had widened the street, and ought to get the benefit of it. Of course, they would not remove the parapets unless they got compensation for what they were giving up. It has been suggested that a landlord should throw his land into the street gratuitously. That would be a very good thing for the community, but we could understand cases in

which it would be a great hardship. In fact, in some cases the landlord would have to throw the whole of his land into the street and have nothing left. Mr. Bryce referred to the difficulty of describing pipes and cables in the register. It will be a difficult thing, but we do not require to have each single cable defined, and in most cases they are laid together and not scattered with other pipes in between them, and the position of these cables will be sufficiently known to the borough surveyor.

On the proposition of the Chairman, seconded by Mr. Curry, a vote of thanks was accorded Mr. Goudie for his paper.

The Members were entertained by the Mayor (Councillor Thompson) to luncheon at the King's Arms Assembly Rooms. In the afternoon the Members proceeded in brakes to Paxton, crossing the border into Scotland. At Spittal, the party were entertained to tea at the Roxburgh Arms by Councillor Greenwood. Later, the Waterworks and the New Borehole were inspected, the return being made by way of Berwick Old Bridge. In the evening, the Members dined together at the Red Lion Hotel, Mr. F. G. Holmes, Govan, in the Chair.

On Saturday, the inspection of the walls and fortifications had to be abandoned in consequence of heavy rain. The Members assembled at the Museum, where Captain Norman, R.N., gave an interesting address on the Elizabethan fortifications.

ANNUAL MEETING IN LONDON.

June 28, 29 and 30, 1906.

THE PRESIDENT'S ADDRESS.

By J. PATTEN BARBER, M.Inst. C.E.

The extraordinary developments which have been made in many branches of engineering during recent years have, perhaps, affected no portion of the profession so much as that which is engaged in municipal work. The passing of the horse tramway, and even of the steam and cable tramways which in some places had supplanted it, the newer methods of sewage purification, the use of reinforced concrete, street lighting by incandescent mantles and high-pressure gas, and the changes in road construction, indicate not only where progress has been and is still being made, but where research and experiment will produce important and beneficial improvements. The vital questions of quicker and easier modes of transit, the relief of streets congested with traffic, housing, road maintenance and cleansing, the abolition of dust from the roads, the disposal of refuse, the purification of trade effluents and the prevention of river pollution, are still to be solved. With regard to some of these, it may be thought that there is little to be done; but no one who gives them serious and intelligent consideration can believe that improvement is unnecessary, undesirable, or impossible, though the method by which it is to be effected may not be apparent. It cannot be assumed that the resources of engineering science are exhausted, that finality has been reached, or that the achievements of enterprise and invention are all in the past. Nor can it be admitted that the subjects by which engineers are faced are so refractory as to defy ultimately labour and skill. Notwithstanding the advance which has been made,

progress is still possible. The work remaining to be done provides scope for ingenuity and objects worthy of the engineer's best and most determined efforts; and it demands the services of highly trained men and the employment of scientific methods. We shall look in vain for any contribution to the solution of the problems which are engaging our thoughts from those who are content to follow beaten tracks and employ old methods. And it is even more hopeless to expect new ideas to spring from uneducated, untrained, and inexperienced persons to whom some authorities think municipal work may be entrusted. Science owes nothing to ignorant haphazard guessings; and engineering science will not be advanced by hazardous plunges in the realm of matter or aimless adventures with materials. These may result in the piling up of a scrap-heap of astounding dimensions, but not in the production of a finished work. Success is at the end of lines of intelligent thought and observation, and of experiments directed by a knowledge of scientific principles. And the need of the present time is a higher knowledge, a keener perception of cause and effect, and a more versatile application of experience in order to deal with new conditions.

When to the difficulties in dealing with these intricate questions are added the responsibilities and duties cast on the engineer by new legislation, and the ever-increasing demand for higher efficiency and the cutting down of cost in every branch of his work, the necessity for maintaining a high standard of professional qualification for those engaged in the municipal service will be apparent. The magnitude of the works which have to be carried out, and the great variety and number of subjects to be dealt with, necessitate an extensive experience and knowledge on the part of the engineer. This is generally recognised by those who appoint him, although it is to be deplored that there are a few authorities which have no higher perception of the qualifications that are necessary for the proper discharge of the duties of an engineer than to appoint a builder who gives part of his time, an auctioneer's clerk, a builder's foreman, a farmer, or a labourer. That it should be possible to entrust important work requiring special knowledge and experience to those who have not the least cognisance of its nature is one of the blots on the system of local administration; and it is to be greatly regretted that the Local Government Board should limit its activity to seeing that a medical officer or a

sanitary inspector is not appointed unless possessing proper qualifications, and make no attempt to secure efficiency in the performance of duties which affect not only the life and health of the community but its expenditure also.

Though a local authority may appoint as their engineer a person who has had neither training nor practice in the work he is expected to control, without so much as a rebuke or a protest from the Local Government Board, the appointment cannot be acknowledged as a qualification for admission to the Association of Municipal and County Engineers. That Association must set up and maintain a standard which will be a guarantee that those who attain it are engineers by virtue of education, training, and practice. And engineers must insist that none but those who are being properly trained in engineering work, or who have received such a training and have acquired a sufficient qualification by subsequent employment on engineering works, can be regarded as members of the engineering profession. It is due to themselves and their profession that they resolutely refuse to acknowledge the irregular and rough-and-ready methods by which some imagine that a sufficient acquaintance with technicalities can somehow be picked up which may be accepted as a qualification in engineering. If it be true that there is no royal road to knowledge, it is also true that there is no by-path or short cut by which the ability to practise in a scientific profession can be attained. I claim for engineering equal rank with the learned professions of law and medicine Like these, its practice requires considerable mental qualities, prolonged and persistent thought and observation, and years of patient study of special subjects. Its scope is as extensive, the subjects with which it deals are as varied, and demand intellectual attainments as high as those professions which, from the skill and learning required for their successful practice, have rightly been considered to hold a foremost place among human callings. It is an indignity to any calling, for the incompetent, the unskilful, or the unqualified, to seek to edge their way into it; in most cases it is a public danger, and the Legislature has in some instances wisely made provision for the punishment of those who usurp powers that they have neither the right nor the qualification to exercise. It is, perhaps, unfortunate that our profession enjoys no similar protection. But the Association will, I trust, ever maintain a high standard, and insist that

none but those who attain it shall be admitted to its ranks. It seems to me that the Association is bound to do this, and to look upon the guarding of its entrance and the approach thereto as a main reason for its existence, and one of the most important objects of its work. It is a duty owing to itself and to the public, the more so since the work of the municipal engineer has become more responsible and his duties more multifarious, and because the Association knows, as no other can, how necessary it is that those duties should be entrusted to none but properly qualified persons, and how impossible it is that they can be performed by those who have not received special training and gained experience in the actual carrying out of the works with which a municipal engineer has to deal. The idea is passing away, though it still lurks where public life is feeble or corrupt, that the municipal service is a professional backwater easy of access to whomsoever is desirous of a pleasant occupation with little demand for capacity or experience. A consideration of the duties of an engineer—the works he has to design and construct, the services he has to organise and keep going, and the administrative and advisory work to be done—or a survey of the numerous sciences and subjects included in the examination which must be passed before even the graduate stage of his career can be reached, must surely be indisputable evidence that this service demands an experience as extensive, and qualifications as high, as those which are considered the essential equipment of one who undertakes the engineering work pertaining to any of the services connected with the State or with great public companies. If the certificate of membership of this Association has any meaning, it indicates that the person whose name it bears has received a proper training in the subjects which are essential to a knowledge of the various works which are carried out in the service, and that he has likewise been engaged in the design, construction, and management of such works, and in the performance of the various duties which have to be fulfilled by a municipal engineer. And further, having been granted by the Association which establishes the standard of proficiency, it is a guarantee that the holder has attained by regular and continuous practice, such a degree of competency in engineering work and the business connected with a public appointment as to justify his being entrusted with the duties of a municipal engineer.

The Council of the Association has shown that it recognises the necessity for raising the standard of qualification for admittance to every grade of the Association, and that, as the duties of the engineer become more responsible and the matters with which he is called upon to deal more intricate and important, there is a corresponding need for a more thorough and extensive knowledge of every subject relating thereto. The long-standing reproach that candidates for the Association's testamur were not required to produce evidence of their having received a fairly liberal education has at length been removed. The requirements of the syllabus with respect to this matter are certainly not too high, and they can hardly have the effect of excluding anyone who has been educated at a school of any standing, while it may be claimed that the Association has done its duty to the profession by establishing a principle which all professions have long deemed essential—viz. that a liberal education must precede a professional training. One may still hear that a youth is to be placed with an engineer because he has a "taste for drawing" or an aptitude for "making things," but these propensities are by no means infallible indications of an embryonic engineer. Drawing and handicraft are not the first attainments that are to be sought. In the beginning, and at the very foundation, there should be a sound education in English, including grammar, composition, history, geography, and literature, and in arithmetic, algebra, geometry, and drawing. Subsequently there should be the study of trigonometry and mechanics, and some knowledge of chemistry, heat, and geology should be obtained. French and Latin are, in my opinion, most desirable additions to the subjects enumerated. There is a tendency to limit the education of the pupil to mathematical and technical subjects; and I fear that, once started on a career in engineering, both he and the assistant are disposed to neglect the study of general subjects, literature, and languages. Seeing that in municipal work correspondence, reports, specifications, descriptions, instructions, and evidence, make great demands upon his power of expression, both in speech and in writing, it is of supreme importance that those subjects which enable him to produce the best work should be sedulously studied, and that the knowledge which has been acquired should not be allowed to pass away for lack of the cultivation which is necessary for its retention. Having prepared himself by education and

training, it seems reasonable that an engineer who enters the public service should have an assured prospect of a career which will bring an adequate return for the labour and expense which have been devoted to qualifying him for the duties he has to discharge. This would be provided by the fulfilment of three conditions.

1. *That an Appointment should only be terminable with the sanction of the Local Government Board.*—Too often the vigorous and faithful doing of duty brings the engineer into conflict with those who desire to evade by-laws, regulations, and Acts of Parliament, and provokes bitter and malignant hostility, which is followed by the desertion of those who should support an officer who conscientiously carries out the work for which he has been appointed. Against a weak and corrupt council a righteous officer should be protected; but so long as that protection is denied, persecution and capricious dismissals will continue. The medical officer of health and the sanitary inspector cannot be deprived of their positions without the consent of the Local Government Board, and there can be no reason for the engineer being without a similar protection.

2. *That fair conditions should be attached to the Appointment, and a just remuneration given for the work and responsibility undertaken.*—It should not be possible to impose on an officer duties and responsibilities which were not contemplated when he was appointed, nor to take advantage of his agreement to devote the whole of his time to the duties of his position by making demands for additional services which necessitate his working early and late for so long as he is physically and mentally capable of enduring the strain. This filching of the leisure which should succeed a fair day's work is as unjust as it is economically unwise. The salary of an officer should be a just equivalent for his skill and experience, and for the duties and responsibilities which he is called upon to undertake, and it should be such as will attract an engineer with the qualifications and a reputation which are proportionate to the importance of the position to be filled. From accounts which appear in the public prints from time to time of discussions on the question of the salaries of the engineering staff, it would seem that there are on many councils those who have but a slight knowledge of the qualifications necessary for the designing and carrying out of public works. To these, plans are superfluous; specifications,

theoretical theses; levels, something which can be determined by the eye; a knowledge of scientific design and construction, and calculations for the determination of effective results, speculative nonsense. And by such as these the salary of an officer who is to carry out the engineering work; to organise and administer services on which depend the life, health, and comfort of the public; to see that buildings, drains and sanitary works are properly carried out; to advise on schemes for railways, tramways, and other works affecting the district; to report and give evidence in connection with legal proceedings; and to perform the innumerable duties pertaining to a public appointment, is fixed at an amount varying from the pay of a labourer to that of a skilled artisan. It is in the interest of the public and of the engineer that the Local Government Board should have the power to insist that the remuneration should be commensurate with the qualifications and responsibilities of the officer. There are, no doubt, districts in which the payment of adequate salaries and the employment of a sufficient staff would be an undue strain on the finances of the community, and in which an attempt is made to meet the difficulty by employing an engineer to carry out, in addition to his proper work, certain minor duties altogether unconnected with the work for which he has been trained. Such an arrangement is both unsatisfactory and injudicious; for the ordinary work of an engineer's department is constantly going on, the employees of the council are regularly at work, and continuous supervision is necessary in order that the work may be properly and economically performed; frequent inspections of the district are required and constant watch must be kept over the buildings and drainage work, street cleansing the collection and disposal of refuse, sewage disposal, and over the many other operations which are carried on unceasingly. The public interest must suffer when the attention of the engineer is diverted from the work which needs his guidance, management, and supervision. The solution of the difficulty would be satisfactorily effected by the payment of a grant towards the salary of the engineer and his staff, as is done in the case of the salaries of medical officers of health and sanitary inspectors.

The effect of the recognition of the two conditions referred to would be to give mutual security to the public and the engineer, and to protect officers against persecution and injustice so long

as they were worthy of such protection. The public would also have an assurance that their work was not deprived of efficient management and supervision through the ignorance or foolish parsimony of false economists. If copies of the reports of the engineer were forwarded to the Local Government Board, it would tend to keep that body informed of an important section of the work of local authorities with which at present it manifests neither interest nor concern. It is incomprehensible that a Government department which is supposed to exercise a control over local government business should limit its solicitude to portions of the affairs of local authorities; that it should enforce the employment of a sufficient staff, the payment of proper salaries, and the satisfactory performance of certain duties in connection with one branch of a local authority's work, and be quite unconcerned about other work of equal importance. When engineers reflect on the improvements and beneficent works which have been forced upon unwilling apathetic local governing bodies, after being urged in vain by able and conscientious medical officers of health, it is impossible to refrain from wishing that their efforts and recommendations might obtain similar support.

3. *That when incapacitated by age, accident, or ill health, an Officer should be granted a just superannuation allowance.*— This principle is an acknowledged right in the State services; it has been adopted by poor law boards and by several corporations, and should be applied to all public servants, whether employed by the State, the municipality, or other popularly elected body. The performance of extra work and the acquisition of greater skill and experience, which in ordinary business bring an accession of remuneration to the individual, in the public service make the public the sole beneficiary. An officer performs innumerable extra services gratuitously. He sees the advantages which those services procure for others, yet receives no equivalent for what he has accomplished. But these circumstances give him a strong claim to a retiring allowance when failing powers render him incapable of bearing the strain of official life.

The work of the Association has hitherto been limited to the development of engineering as related to municipal work. I think that the scope of its operations might with considerable advantage be extended to every branch of the engineer's work. During the last few years assistant engineers have been admitted

as associates of our institution, and the opportunities which have been given to them of attending the meetings and visits to engineering works will not only enable them to increase their knowledge and experience, but induce them to take part in the development of the science of engineering. It will also, I trust, make them realise that they are associated with us in the important duty of improving and advancing the work of our profession so that it may be of the greatest possible service to the public. If the work in the engineer's department is to be of the highest quality it is necessary that each member of the staff should be properly trained for the portion which he has to carry out. And as the whole of the work is of a technical character, special knowledge is required for its performance. But with the exception of the engineering assistants there is no recognised method of training for those who undertake it. No course of study has been prescribed, no mode of preparation has been indicated, no standard of qualification has been established, for the majority of those who are engaged in carrying out duties which form a most important part of the work of the department for which the engineer is responsible. Probably every engineer has felt the need of clerks who have a knowledge of the books, the system of accounts, and the routine of his office, and how comparatively valueless are the services of those who have no practical acquaintance of such work, or of clerks of works and inspectors for municipal works, and of the difficulty in obtaining men of experience and intelligence who are sufficiently trained in the particular works for which their services are required. When the fitness of persons who have offered their services in the capacities referred to has been tested, it has been invariably found that unless they have had a training and long practice in the particular duties which they are required to perform, the result has been exceedingly unsatisfactory and a source of constant anxiety and inconvenience. It would tend to the greater efficiency of the engineer's work and to the improvement of the qualifications of his staff if the Association recognised that the clerks, clerks of works, inspectors, and other officers, are performing important and responsible work which should be done in the most intelligent and efficient manner, and if examinations were instituted for these officers on similar principles to those adopted for engineers. It does not seem to me that our aims are high enough, or that our duty is fully performed, until we

induce all those who are employed by us to attain a high standard of fitness for the work they have to do. Engineers in the municipal service are responsible for a large amount of work which is not of an engineering character, but which must be managed and performed with the same degree of care and skill as the professional work; and those who have a proper regard for their calling will not be satisfied that one portion of their work should be of high efficiency while another should only reach mediocrity. To have the whole excellent should be the lowest at which we aim, and nothing less than high class work all round should satisfy us. To achieve this, attention should be given to the training of those who are engaged in the non-professional part of the work. It is with a conviction that the Association should take an interest in every branch of the work of the engineer's department, and a belief that thoroughness should characterise every part of it, that I urge the duty of doing for others what is being done for the engineering staff.

Municipal work suffers much from our inability to compare it with similar work in cities and rural districts abroad. Statements are plentiful enough from unreliable and irresponsible sources; for the tripper and the holiday tourist are ever ready to publish hastily gathered information and the results of casual observations respecting the superior work and more enlightened methods of the foreigner, and to disparage nearly everything done by British municipalities. But these contribute nothing of practical value, nor do they demonstrate how work may be done here so that our towns may become as delightful as those whose perfections are extolled. That there is much to be learned by a study of the works and methods of other municipalities cannot be doubted, and there would be very great benefit from the reports of commissioners who had inquired into and studied municipal works and organisations abroad and compared them with those of this country. Perhaps the Local Government Board may extend its operations and appoint commissioners having experience of the work of municipal engineers to investigate and report upon similar work abroad for the information of municipal authorities at home.

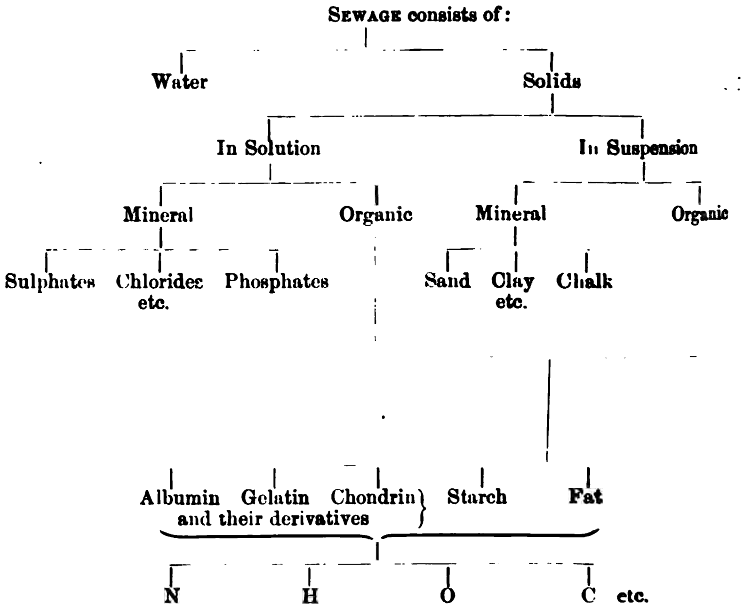
The intention with which the preparation of this address was commenced has been defeated. The subjects with which it was to deal were, first, the principal engineering works connected with municipal work; and second, the engineer, the Association

and its work. A commencement was made with the second division with a view to determining the space remaining for the first; but, alas for the engineering work on which it would have been both pleasanter and easier to speak, the subject seemed to grow in importance and to claim a foremost place. Its hold became firmer, and in the end it forced itself into the chief place, and excluded all reference to its neighbour. And perhaps it is not without advantage to have been held in the grip of so important a theme. For there are occasions when it is well to take a view of ourselves, our aims, our duties, and our responsibilities. Time and affairs move rapidly and unceasingly, bringing new requirements, duties, and the need of work of a higher character. It seems necessary, therefore, that our Association should look itself in the face and discover whether it is doing all that it might, and all that it ought, in order to develop the spirit which will enable its Members to be equal to the demands of the times and the changing conditions of public work. For to be unprepared, ill-informed, antiquated, unscientific, is to be incapable of helping the advancement of the public good.

SEWAGE DISPOSAL, WITH SPECIAL REFERENCE TO IMPROVEMENTS IN PRIMARY CONTACT BEDS.

By W. J. DIBDIN, F.I.C., F.C.S., Etc.

In considering the question of sewage disposal it will be as well to have in our minds the nature of the work involved, and the Author therefore submits the following diagrammatic representation, which may be useful in this connection:—



In order to convert the organic substances into harmless inorganic matter a sufficient quantity of oxygen must be brought

into combination with the nitrogen, hydrogen, and carbon, so as to form nitric acid, carbonic acid, and water.

The quantities of oxygen required for the complete oxidation of the organic compounds, given above, are:—*

1 lb. of	Gelatin requires	.. ..	2·384 lb. Oxygen.
1 „	Chondrin „	.. ..	2·289 „
1 „	Albumin „	.. ..	2·439 „
1 „	Cellulose „	.. ..	1·680 „
1 „	Starch „	.. ..	1·680 „
1 „	Fat (stearic acid) requires	.. ..	3·041 „

The following are the agencies available for the separation and ultimate destruction of sewage matters:—

GRAVITY: by sedimentation; by deposition on adjacent surfaces (contact).

BIOLOGICAL ACTION: by bacteria; by protozoa.

OXYGEN: atmospheric; and from nitrates, sulphates, etc.

The biological action and that of the oxygen are interdependent. Under aerobic conditions, a fresh supply of oxygen is constantly absorbed from the atmosphere. One gallon of water will absorb about 2 cubic in. of oxygen, and no amount of agitation, sprinkling, etc., will increase this quantity, so that any attempt to aerate beyond this degree is trying to fill a given measure with more than it will hold.

The experiments made by Dr. Dupré and the Author in 1884 on the aeration of the London sewage, and given in the Author's evidence before Lord Bramwell's Royal Commission,† clearly showed the fallacy of any attempts to purify sewage by aeration alone. Contact action, by quiet contact, or by slow trickling over surfaces in conjunction with aerobic biological action, is necessary to effect purification.

The various processes proposed for the treatment of inland sewage are:—

1. BROAD IRRIGATION — i.e. natural contact and aerobic action. — *Cause of Failure.* — Limited area of land, causing anaerobic accumulations leading to "sickenings" — too frequently, farming operations, instead of "sewage treatment."

2. CHEMICAL TREATMENT AND SLUDGE PRESSING.—*Cause of Failure.*—Expense of chemicals, leading to undue economy, nuisance from sludge accumulations, and necessity for discharge of chemical effluent on land.

* Purification of Sewage and Water, page 6.
† Q. 19,150 and p. 201, vol. ii., 1885.

3. ARTIFICIAL BIOLOGICAL METHODS, by either aerobic treatment throughout, or by preliminary anaerobic treatment, followed by aerobic treatment of tank effluent.—*Cause of Failure.*—In case of aerobic treatment, limited bed capacity, leading to anaerobic action, as in the case of broad irrigation. In the case of anaerobic treatment, putrefactive action, leading to accumulation of foul gases and deposits, and insufficient after-treatment.

It may be concluded:—

1. That the system of broad irrigation and its ally, intermittent land filtration, will always be successful in dealing with both the solids and liquid matters when the land is sufficient in quantity and quality, and is properly worked so as to secure aerobic action throughout; but the cost and difficulty of obtaining suitable land, and in many cases the cost of working, are matters for serious consideration.

2. That chemical treatment and sludge pressing may be considered matters of ancient history.

3. That anaerobic methods, unless in very special cases, are not only unnecessary, but undesirable in regard to the nuisance caused by noxious emanations, etc.

4. That aerobic processes are, essentially, founded upon simple natural laws, whereby the whole of the waste organic matter of the world is continually undergoing regeneration.

Having thus shortly traced the position of the question, we may now consider the variants in the aerobic equation.

The question resolves itself, as indicated at the commencement of this paper, into two major problems:—

1. The disposition of the solids in suspension.
2. The disposition of the organic solids in solution.

The matters in solution present no real difficulty, as they may be more or less efficiently dealt with by either irrigation, contact beds, sprinklers, large streams, or tidal rivers, according to local circumstances. The River Thames may be taken as a type of the latter method in connection with the disposal of the effluent obtained by the treatment of the whole of the sewage of London, whereby aerobic disposition of the impurities in the effluent is effected without nuisance, as suggested in the Author's evidence before the Royal Commission in 1884.*

It is, therefore, evident that the crux of the sewage question is the disposition of the solid matters, which, in their

* Vol. ii., 1885, Q. 19,109 and 19,113.

accumulated condition, form "sludge." It may be pointed out that the sludge from the London sewage is disposed of *aerobically*, by dilution in the aerated water of the estuary of the Thames.

The distribution of sludge on land, as already indicated in reference to broad irrigation, is now recognised as objectionable. The "*hope*" that it would be destroyed completely in tanks by anaerobic action, no longer "*springs eternal in the human breast*," but the accumulations which have to be removed from time to time are anything but pleasant to the sewage works manager, his assistants, and the neighbourhood generally.

The aerobic contact bed accomplishes the reduction of the solid matters inoffensively and satisfactorily; but in the case of clinker beds at the cost of renewing the filling material at intervals. The success of the method from the sanitary point of view justifies a further search for a method which will accomplish the same result, and at the same time secure continuity of working, and facilities for cleaning the beds without the necessity of removing the material. With this intention, the Author has employed superposed surfaces, supported by distance pieces, and finds that waste slate debris, obtainable at an extremely low price, is admirably suited to the purpose.

The principle involved is simple. If we imagine the possibility of hollowing out a piece of clinker, and thereby utilising the otherwise waste space in the interior, it is obvious that we should obtain double surface action, and the hollow interior would hold water, thereby increasing the water capacity.

Such hollow masses could not be obtained conveniently, nor cleansed. As an alternative, we may consider agricultural drain pipes, which would yield the required conditions as to interior surface and space. These pipes, however, would not be economical.

If a pipe is cut down and bent out it assumes the form of a flat plate. The conclusion is that we can arrive at the conditions indicated in the hypothesis of the hollow clinker, if we superpose indestructible surfaces separated by suitable distances, thus obtaining the contact action afforded by both the upper and lower surfaces of the plate.

This method was found to answer. After a twelve months' trial on a working scale, the Corporation of Devizes determined to fill the primary contact beds at the reorganised sewage works

with slate debris, supported on suitable slate blocks, the distance between the slates being about two inches.

The advantages of the system are that the extra space available doubles the "water capacity," or working power of the bed, and at any time the accumulation of mineral matter, etc., may be flushed from the slates, and the bed restored to its original condition, as new.

The detritus washed off the slates was found to dry inoffensively when exposed to the atmosphere, and to assume a condition resembling ordinary mould.

The beds at Devizes have treated the whole of the sewage of that town since September 1905. The sewage of Devizes is exceptional in nature, in consequence of the large amount of slaughtering which takes place there, in the bacon-curing and other trades, and it was decided to deal with this highly complex sewage rather than interfere with the various trade interests concerned.

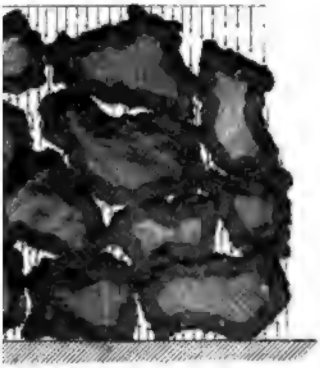
In the Journal of the Society of Chemical Industry for May 1906, was published a paper read by the Author before the Yorkshire section of that society, in which the results of the work done at Devizes were set out in full. It is not to be assumed that no improvement can be introduced in the application of the principle adopted in the first beds constructed to deal with the whole of the unscreened and unsettled sewage by this method. In the meanwhile, the process demonstrates that the natural system of bacterial activity in the presence of a maximum supply of air effects the inoffensive destruction of the solid suspended organic matters in sewage with the maximum of efficiency, and at a minimum cost.

There are, naturally, a few points of detail to be considered in connection with the action of the slate bed. For instance, there are indications that the usual rectangular form of tank might be improved with advantage, as it will probably be found that the residual matters which accumulate in the bed have a tendency to form a natural slope from the sides of the tank to the centre, and it may be a matter for consideration whether this could not be arranged for in the construction of the tank, and so facilitate the process of flushing the deposited matters out when necessary.

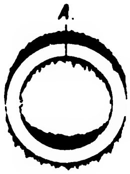
It was found that at the end of each discharge from the slate bed a certain quantity of semi-black matter escaped from

PLATE NO. 1,

; OF THE "PLATE" BACTERIA BED.



SECTION OF COKE BED SHEWING WASTE SPACE IN CENTRE OF PARTICLES OF COKE — AND DEPOSIT ON SURFACE OF COKE.



SECTION OF PIPE WITH DEPOSIT ON UPPER SURFACES OF EXTERIOR AND INTERIOR THUS SECURING DOUBLE WORKING CAPACITY AND SURFACE.

PIPE CUT AT "A" AND OPENED OUT FLAT. FORMING A PLATE.

To face page 340.

PLATE II.

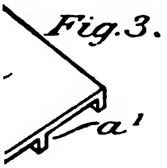


Fig. 3.

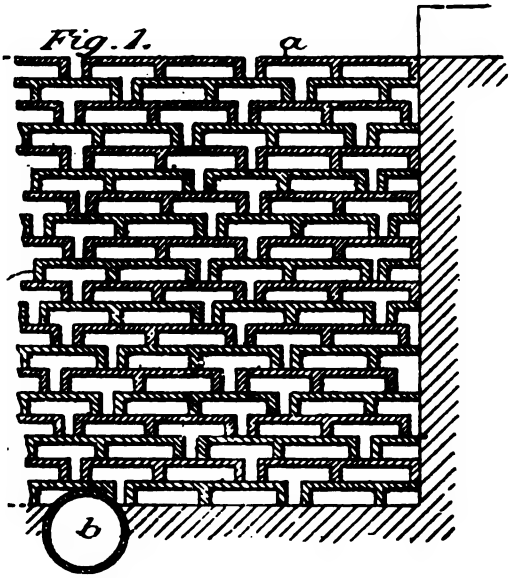
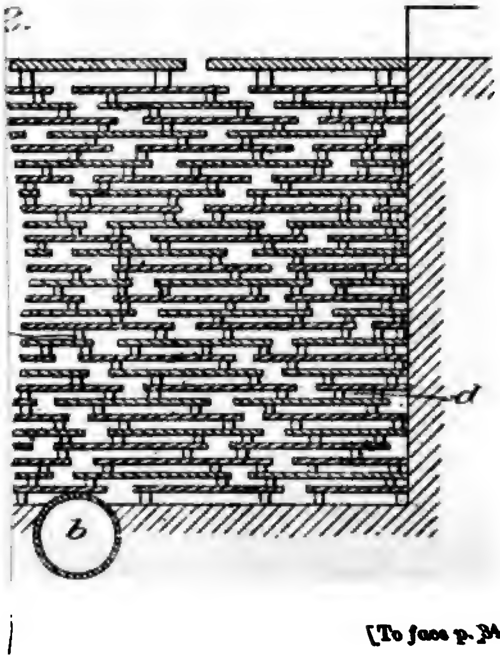


Fig. 1.



2.

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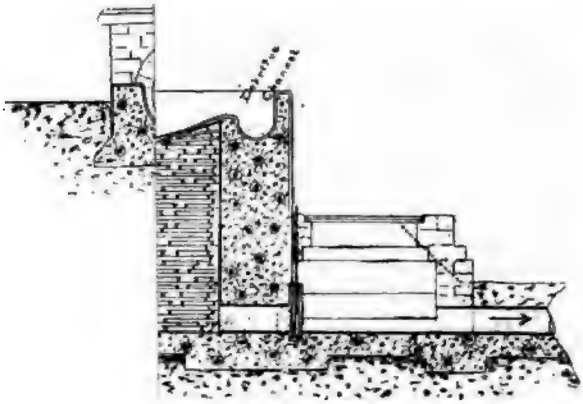
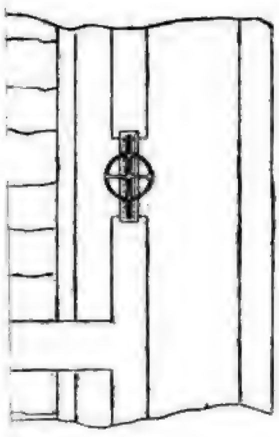
PLATE III.





[To face p. 340

the outlet, which on examination was found to consist largely of the zooglea form of bacteria with some paper fibres, etc. On being collected on the surface of the fine beds and allowed to drain it rapidly underwent inoffensive decomposition, and dried up into a condition resembling garden mould. The escape of this matter from the slate bed may be looked upon as a satisfactory result, as it necessarily tends to maintain the water capacity of the beds by a self-cleansing process which, coupled with the satisfactory result obtained by the "weathering" of the matters so discharged, is distinct evidence of the possibility of effecting the inoffensive bacterial destruction of the solid suspended matters in the sewage.

The experience gained in respect to the actual working capacity of the beds was very definite. When the experimental slate bed was constructed at Devizes it was calculated that the actual water content would be 82 per cent. of the total cubic content. By improvements in the arrangement of the slate filling this is now increased to about 87 per cent. After fourteen months' work at about two fillings per day on the average, the water content was measured and found to have decreased to 50 per cent. Although it was not necessary to cleanse the tank, so far as the working was concerned, it was considered desirable to ascertain with what facility this could be done in regard to the nature of the deposit on the surface of the slate. Accordingly the bed was flushed out by the double valve being opened to full bore and the contents allowed to rush out, instead of flowing quietly as usual. The capacity was then measured and found to have risen to 64 per cent. Some of the slates were then removed in order to permit *sideways* flushing *through* the respective layers of slate by means of a hose. After which the capacity was found to have increased to 82 per cent., exactly equal to the original capacity of the new bed as calculated from the quantity of slate used. The Corporation of Trowbridge having inspected the works at Devizes decided to institute a series of independent experiments, with the view of ascertaining how far the system of slate layers was applicable to the treatment of the effluent from the septic tank into which they propose to pump all the sewage, more particularly for the purpose of securing a good "mixing action" in consequence of the large proportion of manufacturing waste liquors arriving at the works.

They accordingly prepared experimental beds filled with—

1. Slate.
2. Limestone.
3. Broken brick.
4. (Empty.)
5. Westbury slag.
6. Clinker.

The sewage, after twenty-four hours' rest in the septic tank, was passed on to the contact beds, and samples of the sewage and various effluents forwarded to Mr. Charles J. Waterfall, F.I.C., F.C.S., etc., of Bristol, to whom, and as well as to the Corporation of Trowbridge, I am indebted for permission to quote the following results from his report thereon :—

"The result of analysis of the effluents shows the following albuminoid ammonia figures, also per cent. purification.

	Parts per 100,000 Albuminoid Ammonia.	Per cent. Purification on Septic Tank Effluent.	Corrected (arbitrary per cent.) for comparison only.
Sewage	1·00	..	..
Septic tank	0·82	..	..
Slate	0·51	38	60
Limestone	0·54	34	35
Brick	0·51	38	41
Slag	0·56	32	22
Clinker	0·48	41	46

"The beds when full take the following number of inches of effluent from the septic tank—

No. 1 Slate	$6\frac{1}{2}$
„ 2 Limestone	$4\frac{1}{4}$
„ 3 Brick	$4\frac{1}{2}$
—	—
„ 5 Slag	$4\frac{1}{8}$
„ 6 Clinker	$4\frac{5}{8}$

taking the slag bed as minimum, I arrive at the above corrected figures.

"If we take the results of the last three series only, since the tanks and beds have been in good working order, we obtain somewhat different figures :—

	Purification.	Corrected Ditto.
Slate	52 per cent.	82
Limestone	47 „	48
Brick	35 „	38
Slag	32 „	32
Clinker	45 „	50

"It will be seen that in either case slate gives the best results. And in the latter series limestone gives nearly as good results as clinker.

"As regards silting up, there is some difference between the beds as measured by the number of inches of effluent delivered from the septic tank necessary to fill the contact beds after working for three months, as compared with the amount required to fill the same when first started:—

Slate	$\frac{3}{16}$ in.
Limestone	$\frac{1}{16}$ "
Brick	nil
Slag	$\frac{2}{16}$ "
Clinker	$\frac{1}{16}$ "

"In conclusion, I am of opinion that you may safely use limestone for filling your primary contact beds. The results that the limestone gives, particularly in the last series of tests, show it to be a useful material for the above purpose. The slate gives excellent results, and speaks for itself, but the question of cost, which is outside my immediate province, must guide you between slate, limestone, and clinker.

Experience with the system is also being gained at High Wycombe, where Mr. T. J. Rushbrooke is carefully watching the two experimental beds, which are giving decidedly satisfactory results, and, in conjunction with the experience gained at Devizes and Trowbridge, justifies the theoretical deduction upon which, as already explained, the system is based.

Plate-Beds filled with Slate at High Wycombe.

A special series of independent analyses of average samples of the sewage and plate bed effluents under different rates of filling have been made by the Clinical Research Association by direction of the Corporation of High Wycombe with the following results. Each sample is the average of twelve hours flow on August 22, 1906, and the results are expressed in "Grains per gallon."

The analysts' concluding observation to the effect that the percentages of purification are rather low, was made under the

—	1 Sewage entering Beds.	2 Effluents from Slate Bed No. 1, 3 Fillings daily.	3 Effluents from Slate Bed No. 2, 2 Fillings daily.
Appearance	Cloudy	Cloudy	Cloudy
Odour	Distinct	Slight	Slight
Reaction to litmus	Alkaline	Alkaline	Alkaline
Chlorine	2·65	3·05	2·00
Ammonia, free	1·050	1·070	0·870
„ albuminoid	0·150	0·082	0·094
Oxygen absorbed in 4 hours, 27° CO ..	0·481	0·342	0·270
Dissolved solids—			
Total	29·68	28·00	25·69
Volatile	3·50	2·03	1·33
Suspended solids—			
Total	10·22	3·64	2·66
Volatile	5·11	0·56	0·84
Odour on incubation	The odour of the effluents is slightly increased on incubation, but no fermentative change seems to take place.		
Purification per cent. based on albuminoid ammonia.	—	46	38

Remarks.—The above results show that the percentages of purification are rather low.

impression that these are *final* bacterial effluents and not from preliminary sludge digesters as the plate bed was only intended to be.

These results are exceedingly satisfactory, the effluents being non-putrescible and containing less impurity, as judged both by the albuminoid ammonia and oxygen absorbed tests, than is considered permissible in first-class effluents, whilst the volatile suspended matters are reduced to less than one grain per gallon.

It will thus be seen that in the case of High Wycombe the plate beds are yielding effluents up to the recognised standards of purity, thereby doing better than was anticipated, and more than justifying the claim that they deal with the suspended matters and have a marked effect upon those in solution, thereby preparing the sewage for final treatment on either land, fine contact beds, or sprinkler beds.

It will be noticed that excellent results were obtained at even three fillings daily, so that as the beds have a working capacity of double that of coke or clinker beds, and as the usual requirement of the Local Government Board is that such beds must be

worked at only one filling daily on the basis of the dry-weather flow, the High Wycombe beds are doing *six times* the work of ordinary coarse coke or clinker beds when working under official conditions, and yielding by that single treatment an effluent sufficiently pure to be discharged direct into ordinary streams. It will, of course, be noted that the High Wycombe sewage is largely diluted with subsoil water, but the plate beds enable this to be dealt with without the necessity for expensive works, or cutting off the subsoil streams which under existing conditions exercise so beneficial an influence in flushing the sewers.

SLUDGE TREATMENT IN RELATION TO SEWAGE DISPOSAL.

By J. D. WATSON, M. Inst. C.E.

Considering the great changes that have taken place in the views of sanitarians in ten short years, it behoves us to approach the question of sewage purification in a less dogmatic manner than some of us have been in the habit of doing, and to express our conclusions and the results of our experience without presuming to say that because a certain course is suitable at one place, it must necessarily be suitable at another; that because a scheme is found to answer well in the north, it must be equally applicable to the south.

Had sewage always been composed of waste from dwelling houses, there might have been some excuse for this attitude, but where domestic sewage is mingled with trades waste which contains acids, sulpho-cyanides, pickling liquors, brewery wastes, wool washings, etc., it ought to be obvious to the least intelligent that different methods of treatment must exist, and that any attempt to deal with the question in a stereotyped manner will only put back the hands of the clock.

In order to guard against misapprehension, therefore, it should be clearly understood that in the remarks and recommendations that follow, the Author is dealing with a sewage having the following characteristics:—

Daily Average Analyses of Birmingham Crude Sewage for Three Years, 1903–5 Inclusive.

Parts per 100,000.

Dissolved solids.	Suspended solids.		Free and Saline Ammonia.	Albuminoid Ammonia.	Chlorine.	Nitrates and Nitrites as Nitrogen.	Oxygen absorbed.	
	Total.	Organic.					Unfiltered.	Filtered.
119·3	74·3	44·9	4·05	1·57	20·2	·92	27·56	15·79

The work of sewage purification may be said to be divided into the following sections:—

(*a*) Arresting and disposing of solids, like road grit, coal slack, rags, etc., which in the bulk form sludge containing 50 per cent. water.

(*b*) Precipitating organic sludge containing 90 per cent. water, converting it into an inodorous substance before disposing of it on land or otherwise.

(*c*) Aëration and nitrification of sewage, *per se*, and its subsequent discharge into a river in a state that will increase in purity as it flows down stream.

This paper will deal briefly with phases of the first two sections of the subjects, viz. (*a*) and (*b*), and this appears to divide itself into three main considerations:—

First.—The means of effectually arresting solids;

Second.—Removing them quickly; and

Third.—Disposing of them without nuisance.

It is possible to treat some sewages in their crude state without abstracting the grosser solids, but where there is a large quantity collected from a large area, particularly if trades waste constitutes a prominent feature of the sewage, it may be taken that means for abstracting the solids must form an essential feature of every purification scheme.

The methods adopted for abstracting detritus from sewage are numerous, and must necessarily vary with circumstances, but it may be assumed that a tank or grit chamber *plus* some mechanical arrangement for cleaning the same is absolutely indispensable. The size of this chamber, in its relation to the volume of sewage to be dealt with, is a subject that requires the closest attention before any special design is decided upon, and with all the information and experience in the possession of engineers few feel able to lay down an unvarying standard of construction, either as regards form or capacity.

After not a few trials, and a few failures, the Author has come to the conclusion that the grit chamber should be, where possible, in the form of an inverted pyramid, and that it should be fitted with a mechanical arrangement for dredging out the solids capable of being set in motion at the discretion of the attendant.

In principle, an inverted cone would equally serve the purpose of arresting suspended matter, but the apex of a cone is

a most awkward shape for fixing anything in the nature of a dredger, and for this reason also a true pyramidal form is not exactly ideal. Perhaps the shape best of all for a detritus-chamber is an elongated pyramid—inverted, of course.

The accompanying plan of a work recently installed to deal with the road grit and sludge in sewage emanating from a district having a population of about 75,000 persons will illustrate the nature of the grit chamber and method of dredging and screening desiderated.*

It frequently happens that one has to deal with works that have been constructed for many years, and in such cases, the shallow rectangular tank is usually found to exist. This was so at Birmingham, where two tanks of this form, capable of holding one million gallons each, were constructed in 1859, by the late Mr. Thomas Hawksley. Until 1901, these tanks and others of a similar kind constructed subsequently, were used as precipitation tanks. They were divided into three bays or sections, and milk of lime in the proportion of 12 grains per gallon was mixed with the sewage before it entered the tanks for the purpose of neutralising acids, and assisting in the precipitation of suspended solids.

As will be readily understood, the road grit was for the most part arrested in the first bay of the tank, the second and third bays arresting sludge containing a larger proportion of liquid and organic matter. When these tanks were first used, the greater part of the cleansing operations was done by manual labour. Subsequently fixed stationary dredgers were erected for the purpose of lifting into wooden carriers sludge containing 90 per cent. water. These dredgers were found to be unable to cope with the work required of them, and Tangyes direct-acting pumps were employed to assist them, and more recently a travelling crane, fitted with a Priestman grab, was employed to lift the grit out of the first bay of each tank. This process was continued for many years, but the amount of sludge arrested was so enormous, amounting to about 260,000 cubic yards per annum, and the difficulty of dealing with that sludge when it was arrested so great, that it was evident some drastic improvements were required, if the difficulties were to be grappled with successfully.

The chief difficulty did not lie in the want of ability to

* *This plan will be found in Vol. XXXI., p. 30.*—T.C.

arrest the sludge, for the tanks did this part of the work admirably, size in relation to the volume of sewage being an important element in the case.

The average rate of flow of sewage through the tanks was until 1902 2·05 ft. per minute, and the average deposition of the solids due to a combination of mechanical and chemical action 75·9 per cent., and to mechanical action alone 56·4 per cent. of the total suspended matter in the sewage.

Since the number of tanks was increased the rate of flow has been reduced to 1·2 ft. per minute and the deposition without the aid of chemicals increased to 59 per cent.

At Hanover, a set of experiments was made a few years ago on tanks 246 ft. long, with the view of ascertaining the most advantageous rate of flow. With a velocity of 9·44 in. per minute, 62·7 per cent. of deposition was obtained; with a velocity of 14·7 in. per minute 61·7 per cent. was obtained; with a velocity of 17·43 in. per minute, 57·3 per cent. was obtained.

The nature of the sewage dealt with has a considerable influence on the deposition of sludge, i.e., at Birmingham there is a large proportion of macadamised roads and streets, with the result that inorganic solids, like road grit, precipitate quickly and assist the deposition of lighter substances in their downward course.

Probably the chief difficulty lay at Birmingham in the inability of the executive, by reason of inferior plant, to empty the tanks quickly. During the liming process the roughing tanks were not emptied more frequently than once per month, and the process of emptying occupied a week. The finishing tanks were emptied about once every three months.

In June 1902 both roughing and finishing tanks were increased in number, adding nearly 50 per cent. to the tankage. While this addition had the effect of improving the work of arresting sludge, the amount arrested going up by 23 per cent. (reckoned per million gallons treated); it also had the effect of making more evident the weakness of the plant available for removing sludge from the tanks. In April 1903, however, new pumping plant for raising sludge was brought into use. By means of this each roughing tank could be emptied once a week, instead of once a month. This virtually means an increase in effective tank capacity, and still more effective sedimentation

was obtained, the sludge removed per million gallons rising during the following year by 44 per cent., while the suspended solids in the roughing tank effluent fell from 29 parts per 100,000 to 17 parts per 100,000. The suspended solids in the septic tank effluent fell during the same period from 23·2 to 13·1 parts per 100,000.

A curious phenomenon was now observed in the septic tanks. The quantity of suspended solids was much reduced in the liquor passing into these tanks, and yet they began to silt up, whilst their activity as septic tanks was much reduced. This was accounted for as follows. The organisms in our crude sewage are remarkably few in number, such observations as have been made giving an average of 500,000 or so per c.c. The long sojourn of much of the sludge in the roughing tank under the old method of emptying (once a month) resulted in much putrefaction with consequent increase in the organic life in the tank liquor. The liquor, therefore, being passed to the septic tanks was in an incipient septic state under the old conditions. Under the quicker methods of sludge removal this incubating ground for the microbes was removed, whilst the organisms already in the septic tanks were deprived of much of the food (sludge) they formerly received.

For this paper it is unnecessary to describe the nature of the new pumping plant beyond stating that in conjunction with increased power to lift and force sludge, an underground main was laid for its convenience down the valley. Branches were fixed to this main, which is about three miles long, at every 200 yards, and to these branches are attached, when required, portable steel pipes to convey sludge to any particular field.

This addition to the plant effected a great change in the work of sludge disposal, and at first glance it appeared to have defeated its own object, inasmuch as the more efficient the means of dealing quickly with the sludge the more there was to deal with. One day was now sufficient to empty one tank, and as there were but five large precipitation tanks to empty (the smaller tanks all having been converted into septic tanks), the whole of the tank cleaning operations were confined to five days of the week, beginning with Monday and ending with Friday.

Having now got to the stage when it was practicable to remove for a sum of 3*d.* per cubic yard 80 per cent. of the suspended solids in five days of ten hours per day (without reckon-

ing the time required to pump the supernatant water), and what was of even more importance, the ability to remove sludge from the tanks before it was sufficiently decomposed to give rise to nuisance, a great advance on former conditions had been achieved, but there was still something to do, viz., to abate the nuisance arising from the exposure of semi-putrid sludge in the fields.

Lord Bramwell's Commission stated that getting rid of the sludge was the crux of the sewage disposal question, and to be obliged to get rid of 800 tons of it per day without creating a nuisance, or what is less easy, without giving rise to complaints, is a matter of the greatest difficulty. Where it can be shipped out to sea whenever it is taken out of the tank, the difficulty is almost solely an economic one, but where it has to be pressed into cake, or got rid of on land, the difficulties are both hygienic and economic.

In the case of a large farm the usual practice has been to spread the sludge in great shallow lagoons over an area of ground and allow it to dry sufficiently to permit of its being dug into the ground as a gardener digs in manure, a practice good in itself, but one which frequently gives rise to nuisance, not only when the work is being done, but afterwards when the sludge is disturbed by the plough. Then it frequently happened that the area under sludge at one time was so great that it was impossible to cope with the nuisance.

This method of disposal was improved upon, and the risk of nuisance minimised to a very large extent, by cutting trenches 3 ft. wide and 18 in. deep, and pouring the sludge into these trenches, covering them over with earth as soon as practicable; but even this method contained elements of nuisance which were most difficult to contend with during certain seasons of the year, especially where the amount of sludge to be got rid of occasionally amounted to three quarters of a mile of trenches per day.

Many experiments were tried to get rid of the objectionable smell of the sludge, some of which may be enumerated, viz.: soot; a combination of lime and soot; spraying paraffin on the surface; a substance advertised by the name of "Chlorous"; a solution of bleaching powder containing hypochlorite of calcium; none of which could be regarded as efficient, and all of which were costly.

The most efficient experiment in the direction of deodorising

the sludge by artificial means was the application of a solution of bleaching powder containing hypochlorite of calcium, having 35–36 per cent. of available chlorine as it was pumped from the tanks into the sludge main in the proportion of 35 lb. by weight of powder to 20,000 gallons of sludge. This experiment, when tried in the laboratory, was found to be a great success, converting the nauseous smelling sludge into a pleasing smelling substance, but when the solution was added to the sludge at the outfall works, where it was all mixed up before it was drawn through the pumps and churned up in the pumping main, the results were not so good, and the greatest possible difference between the laboratory experiment and the actual working was made manifest.

Since lime treatment was abandoned and septic treatment inaugurated in 1901, the whole of the land between Saltley and Curdworth in the valley of the Tame has been subjected to irrigation by septic sewage, and on several occasions when the amount of suspended matter in the septic sewage was more than usually great, the Author was much struck by the absence of objectionable smell. On looking at the land grips, which in places were covered with a thick black paste deposited only the day before, or it may have been on the day of observation, he was amazed to find that the sludge had practically no smell at all. This observation led to further observations which all tended to confirm the first, that septic sludge, or sludge which formed the residuum of the septic tank process, was devoid of fetid odour, and indeed that it required a very acute sense of smell to detect odour at all.

The outcome of this observation brought about the emptying of a septic tank which had been in constant use for three or four years, with the view of ascertaining whether the sludge in bulk would have the same inoffensive characteristics. The experience gained was perfectly satisfactory, the residuum in bulk having been proved to be as inodorous as the thin layers which were first observed. This experiment was repeated from time to time always with the same results, and in January 1904, all the septic tanks were emptied and the residuum pumped on to an adjacent field about eight acres in area, where it was allowed to accumulate, until in its liquid state it measured on the average 18 in. deep. This sludge was allowed to lie for seven months without being touched, and during that time it

continued to retain without variation its inodorous character, whether the temperature was high or low. Father Time rendered his help, and the depth of the sludge was reduced both by evaporation and absorption until the quantity to be dug into the ground did not exceed from 6 in. to 9 in. in depth. This was then ploughed into the ground by steam plough, allowed to lie for a month or two until the season for sowing rye came round, when that cereal was sown. The crop raised, however, was not satisfactory, but this was not unlooked for, as the residuum of the septic tank process contained such a large amount of metallic salts that when it was used by itself for the purpose of ascertaining whether common garden seeds could be made to germinate in it, it was found that the seed (perilla) would not spring into life. The residuum was then mixed with an equal proportion of black earth, and again sown with similar seeds, when about one third of them germinated, but did not mature. Not until the proportion of residuum was reduced to one fourth of the black earth did the perilla show signs of a moderately healthy life. It was therefore quite clear that it was a mistake to run so much sludge on the surface of the land at one time, and in subsequent working not more than half the amount of sludge has been put on the surface of the ground, with far more satisfactory results; besides, the shallower depth dries much more quickly, and the steam plough is better able to cover it over with good soil. In the first trial a mistake was made in the seed chosen, viz., rye. The roots of that cereal penetrated too far into the ground, going in fact into the residuum which had been purposely ploughed under the surface; in the subsequent trials Italian rye grass was sown, with satisfactory results.

An analysis of this residuum was made by our chemist, and is as follows :—

The inorganic matter contains :—

		Per cent.
Silicious matter (sand, etc.)		20·00
Oxide of copper		1·71
Oxides of iron and aluminium		20·00
Oxides of zinc, manganese and nickel	(about)	5·00
Lime and magnesia	(about)	7·00
Oxides of phosphorus and alkalis	(about)	2·00
Organic matter in dry sludge		44·67
„ nitrogen „ „		2·47

While these observations were being made in the early part

of 1904, certain experiments were being made on tank treatment. As the Author already stated, between April 1903 and April 1904, the roughing tanks were being cleaned out much more frequently, and the result was to denude the septic tanks of a considerable portion of the liquid organic sludge which formerly went to feed them. It was established that although the efficiency of the roughing tanks for sedimentation had been increased 44 per cent., the septic tanks gave unmistakable evidence of becoming less active. Instructions were then given that a considerable portion of this lighter sludge should be pumped from the roughing tanks into the septic tank inlet channels and made to mix with the sewage passing from the roughing tanks to the septic tanks. This liquid sludge was greatly increased until a volume equal to 30 per cent. of the total sludge deposited was passed into the septic tanks daily. The result was almost an immediate restoration of active fermentation in the septic tanks.

When the importance of this discovery was realised, it became necessary to reconsider the position of the septic tanks in relation to purification of sewage, and the first question that occurred was how much sludge does the septic tank get rid of. This the Author answered in 1902 in giving evidence before the Royal Commission on Sewage Disposal, as 10 per cent.; a similar answer was given to the same Commission in 1905. Since then (while the most active fermentation has been maintained) observations go to show that little more than 10 per cent. of the total solids entering the septic tanks is converted into gas.

This figure shows a considerable discrepancy with those given by Dr. Kinnicutt, of Massachusetts, U.S.A., in a recent paper, where he pointed out that Exeter, Leeds, Manchester, and Worcester (Mass.) agreed in stating that about 25 per cent. of the organic sludge was gasified by bacterial action in a septic tank.

The quotation is from memory, and is of course subject to correction, but the disparity between Birmingham and the other places is so great that it calls for some observation, and it should be ascertained whether all the estimations were carried on for a long or short time, and whether or not they were confined to comparatively small volumes of sewage. In Birmingham, the estimation of 10 per cent. is the result of nearly five years' observation of an installation dealing with 25,000,000 gallons of sewage per day.

Having arrived at the conclusion, notwithstanding the experience of others with other sewages, that the Birmingham sludge could not be gasified in a septic tank to a much greater extent than 10 per cent. of its bulk, and having discovered that the sludge or residuum formed in the bottom of the septic tanks is without objectionable smell, the Author came to the conclusion that the real solution of the sludge difficulty was probably to be found in utilising the septic tanks as manufactories of septic sludge, if that phrase may be used to denote the residuum of the fermentation process, more particularly as the only sacrifice involved in the change was the more frequent emptying of the tanks. Instead of cleaning once every two years as formerly, last year they were emptied on an average once in seven weeks.

No sooner had this resolution been taken than instructions were given to carry it into effect.

First.—By connecting all the suction pipes in the septic tanks—they formerly terminated at a temporary pumping station in the middle of the tank area—to the engine and pump-house.

Secondly.—By converting as much of the precipitation or roughing tanks into septic tanks as could be spared, bearing in mind the necessity for retaining detritus tanks.

The first work calls for no comment.

To determine what proportion of the roughing tank should be retained to act as a detritus chamber, was not without difficulty. As, however, there were several division walls in the existing tank, it was possible to act cautiously by contracting the size of the existing chamber from time to time. Ultimately it was determined that the most suitable capacity of the detritus chamber should be 20,000 cubic feet per tank, representing 4000 cubic feet per million gallons treated.

The desiderated system, although incomplete, has now been in operation for more than a year, and the following brief description of the working will help to elucidate the method adopted.

The sewage enters the roughing tanks through the detritus chambers, where it travels at the rate of 1·2 ft. per minute, leaving behind in the detritus chamber the larger proportion of its organic matter, i.e., fine sand, gravel, particles of coal, cinders, wood, leather, animal hairs, etc., and in the septic tank, which is reached by passing over a submerged weir, and under a scum

board the finer particles of suspended matter that escape the detritus chamber, and which include a larger proportion of organic matter such as animal fat, paper, fragments of food, vegetables, and much fæcal matter, are deposited.

Only a floating scum board separates what looks like a placid liquid charged with fine sand, and a water resembling black ink, fermenting so actively that it may be heard as well as seen, a condition which was attained only after the greatest difficulty owing to the paucity of micro-organisms in the sewage.

The large septic tank maintains its activity, notwithstanding the fact that a scum is positively discouraged; the object of this is to allow the suspended matter which is inflated by the gases rising from the tank liquor, to pass freely to the septic tanks proper.

The detritus tank is emptied once a week. The supernatant water is pumped off and the slimy part of the sludge is pumped into the channels which feed the twenty septic tanks with sewage, thus mixing sludge and sewage together. That part of the sludge which is too highly charged with sand and grit is sent direct to the sludge trenches, and the still more solid stuff is lifted out by steam grab and buried at once.

Tanks 1, 2, and 3 are treated in precisely the same way, only the detritus tanks being much larger there is more work to be done.

The following table shows the probable effects of altering tanks Nos. 1, 2, and 3 to correspond with Nos. 4 and 5, and the leading feature to be observed is that there would be an economic saving on every process, and an aggregate saving of 482*l*. per annum, less cost of constructive work necessary to effect the change:—

TABLE BASED ON FACTS OBTAINED IN WORKING TANKS FOR THE YEAR ENDED MAY 1906.

Cube yards.			£	s.	d.
19,277	=	Quantity of sludge (90 per cent. water) pumped to trenches from each of tanks Nos. 1, 2, and 3 per annum.			
7,284	=	Ditto, ditto from each of tanks Nos. 4 and 5 per annum.			
11,993		Difference × 3 = quantity pumped to trenches that could have been obviated = 35,979 cube yards at 2·85*d*.	427	5	0

			£ s. d.
36,202	=	Quantity of sludge (90 per cent. water) pumped into septic tanks from each of tanks Nos. 1, 2, and 3 per annum.	
15,016	=	Ditto, ditto from each of tanks 4 and 5 per annum.	
21,186		Difference × 3 = quantity pumped to the septic tanks that could have been obviated = 63,558 cube yards at say ½d. per cube yard	130 0 0
		In the same way it is calculated that it would be unnecessary to pump 29,573,232 gallons of supernatant water per annum if detritus chambers of tanks 1, 2, and 3 corresponded in size with tanks 4 and 5. 29,573,232 gallons at say ½d. per 1000 gallons..	60 0 0
			617 5 0
		From this must be deducted the extra amount of sludge to be removed from the septic tanks = 90 per cent. of 35,979 cube yards = 32,381 cube yards at 1d. per cube yard	134 18 0
		Probable saving of working costs if tanks 1, 2, and 3 coincided in size with tanks 4 and 5..	482 7 0

In 1900, the last year when lime was used, the cost of sludge disposal was 7·2 pence per cubic yard. For the year 1904 after the new plant was introduced, the actual cost was 2·968 pence per cubic yard, and since it has become practicable to use the inodorous sludge for the purpose of filling up depressions in the various fields to which it is applied (thus obviating the cutting of trenches, etc.), the cost has been lowered to 1·85 penny per cubic yard. All the figures are comparative, and the lowest will not be reached until tanks Nos. 1, 2, and 3 are made to approximate to their fellows.

DISCUSSION.

Lieut.-Colonel A. S. Jones, V.C.: I have pleasure in proposing a vote of thanks to the Authors. Mr. Watson appears to agree with Mr. Dibdin that the sludge is the crucial difficulty. Mr. Watson apparently empties his septic tanks once a week, so there is very little septic action. He puts the sludge straight

into the land while it is comparatively fresh ; if there was full septic action, it would be a nuisance. Mr. Dibdin disposes his slates in *horizontal* layers, while the slabs in Dr. Travis's hydrolytic chamber stand nearly *vertical* to facilitate the descent and removal of the solid material arrested thereon, more or less worked over and changed by bacteria. Ample provision was made by Dr. Travis for removal from the hydrolytic tanks and chambers of any arrested solids for early burial in the earth, which is also the best point in Mr. Watson's practice, while Mr. Dibdin still pins his faith to aerobic bacteria, and makes light of the cleaning of his slates, with much resort to the old humus or garden-mould theories of the inoffensive nature of the residue, for which he tardily provides occasional flushing out with a hose pipe. It is, indeed, to be hoped that Lord Iddesleigh's Royal Commission, which has had eight typical sewage farms under observation for three years, will ere long pronounce an important opinion which will sum up the facts on which so many professional papers have been put forth, and place the issue in an intelligible shape before sanitary authorities. I fear that the financial aspect of the question was beyond the reference to the Commission, but the important thing to us is that we should know the cheapest and best means of getting rid of sludge. The Royal Commission does not appear to have gone into the cost of each case, but I do think when the matter is fairly treated that the cost will be found to be less with land where it is to be had at a reasonable price than any artificial treatment. I believe that the authorities of large towns, like Nottingham and Reading, and the War Department, would have no objection to publishing the financial accounts of their farms; it is not for me to push those authorities in any way. If the Royal Commission can be brought to look at the financial side of the question, it will be a great advantage.

Mr. H. P. Raikes: I gather that Mr. Watson recommends the use of tanks which are constructed with the bottom in the form of a cone. This form of the tanks will, no doubt, facilitate the removal of sludge by gravitation, but will also have the effect of considerably increasing the percentage of moisture in the sludge. We have been told by Mr. Watson that the percentage of solid matter that is resolved in the Birmingham septic tanks has been found not to exceed 10 per cent. That is a very interesting figure, but it would be very much more interesting

if we knew what percentage of moisture was contained in the sludge ; for example : if we have 5 tons of absolutely solid matter in 100 tons of sludge, we say it contains 95 per cent. of moisture, whereas if there is 90 per cent. of moisture, there would be 5 tons of solid matter in 50 tons. It may be that only 10 per cent. of the suspended solids are resolved in some septic tanks, but there is usually a much more important effect in reducing the volume of sludge due to the smaller percentage of moisture in the sludge from septic tanks as compared with precipitation tanks.

Mr. C. H. Cooper: There is only one out of the four conclusions Mr. Dibdin has arrived at that one feels inclined to question and that is No. 2, in which he says that chemical treatment and sludge pressing may be considered matters of ancient history. As regards chemical treatment, I am quite willing, except in certain cases, to agree with him, but as regards sludge pressing I am not. We have heard from Mr. Watson that he reduces the sludge by septic action only 10 per cent., a very different figure from what I have heard Mr. Watson mention before, and, I may say, an extremely different figure from what the septic people spoke of when they brought this wonderful tank before the public. We were then told the tank would get rid of all the sludge. To-day we have heard of the difficulty of pressing septic sludge, and that it is practically of no manurial value as it would not germinate the seed placed in it. That being so, does it not come to this: that it is better to get ordinary sewage sludge pressed into cake, which is an article that can be handled comparatively easily? For instance: the cake is only one-fifth of the volume of the original sludge. As to the method adopted at Birmingham, Mr. Watson cannot get tank sludge containing only 90 per cent. of water to travel through an arrangement of the sort he describes —it will not flow freely. It must have a much larger percentage than 90 per cent. of water. The method Mr. Watson has got at Birmingham, can only be adopted in a few cases. At Wimbledon I could not think of running sludge on to land, so that in our case, we are compelled to press sludge, a method which is not a matter of ancient history. As regards Mr. Dibdin's method of getting rid of sludge between slates, I grant him it is a very interesting experiment, as is the hydrolytic tank at Hampton. I would ask how, in practice, these slates are to be cleaned. Supposing you had an acre of such beds, how are you to get rid

of the sludge? I take it an acre would be a limited area on which to get rid of the sludge of a population of 30,000. Consider what it would be to clean out an acre of these slates. The cost would of necessity be great, and the cleaning would have to be done from time to time. Although it has not been mentioned in either of the papers, I might mention the sprinklers on the Birmingham farm. They have got something like 2000 acres. With an area of that kind the filters should not be resorted to until it has been found that the land available is unable to deal with all the sewage. Filters should then be resorted to in order to treat so much of the sewage as cannot be dealt with on land.

Mr. A. E. COLLINS: About eleven months since, I took my Sewage Treatment Committee to see the Birmingham works. We had been visiting a large number of works in various parts of the country, and we came to the conclusion that Birmingham was the best managed from the point of view of efficiency and economy. When we considered that a population of one million was having its sewage treated in that valley, we were very much struck with the absence of anything like offensive smell, which I believe to be due to the skill and care of Mr. Watson in the treatment of the sewage. It is interesting to notice that Mr. Dibdin has come to the same conclusion as Dr. Travis, as to the "effect" of passing sewage over surfaces and in intimate contact therewith. I think Dr. Travis's system is better than Mr. Dibdin's in one important respect, viz. that in the Travis system the surface is arranged to be practically self-cleansing. That may be taken as an answer to Mr. Cooper. From what I have seen by watching the cells at Hampton, the slates are self-cleansing. When a certain amount of solids have attached themselves to the slates, those solids fall off of themselves and are removed by gravitation. That is a very great thing. If you can get sludge out by gravitation, you have arrived at the cheapest method; at least I do not see how you are to do it cheaper. One advance that has been made by Dr. Travis upon what I was shown at Hampton, consists of filling the cells with self-cleansing surfaces so that practically the separation of the solids in solution and suspension is effected in one tank. What has been done till recently at Hampton has necessitated two tanks. It seems to me this will effect considerable economy in the cost of works. As to the treatment of sewage by

irrigation, I may say that even in a city like Norwich, which is the centre of an agricultural district, local authorities cannot get sufficient land. The Norwich Corporation have at present 500 acres of land, of which 350 acres are available for irrigation. They desired to increase it to 1000 acres, but when they set to work to obtain further land, so much opposition was aroused all through the district, that it was impossible to carry the scheme through. I have recently recommended the adoption of the Travis system, and application is about to be made to the Local Government Board for the necessary authority.

Mr. R. A. MacBrair: We have two sludge presses which answered very well for ten years, but we found them at length inadequate for the growing work, and so expensive that we abandoned their use, and now run the sludge by pipes into lagoons. This saves over 1000*l.* a year. If there are gentlemen present who think sludge presses are not obsolete, we shall be very pleased to sell them two. We deal with the whole of the sewage of a population of 53,000, and dig our sludge into lagoons at a cost of 160*l.* a year. We have 16 acres of land on which to place it, and get round in five years. Anyone will find that if he can run his sludge into lagoons, he will save money.

Mr. J. Lemon: The theory that the bacterial method freed us from the difficulties with sludge is exploded to a very great extent by the paper of Mr. Dibdin. I can quite indorse what he says. We have not got rid of the difficulty by simply putting the sludge into tanks and then afterwards upon filter-beds. Those tanks will require emptying at certain intervals, and a great deal more often than we were led to believe. We were told at Exeter they would last five years, but I do not think we entertain that view now. The sewage at Exeter was of a very mild description. We are told by Mr. Dibdin that we can get over the difficulty by using slates in the beds and flushing out the solid matter which adheres to the material. And Mr. Dibdin certainly gives us some remarkable results. He says, "When the experimental slate bed was constructed at Devizes, it was calculated that the actual water content would be 82 per cent. of the total cubic content. By improvements in the arrangement of the slate filling, this is now increased to about 87 per cent. After fourteen months' work at about two fillings per day on the average, the water content was measured and found to have decreased to 50 per cent." I want you to

particularly notice this. Mr. Dibdin goes on to say, "Some of the slates were then removed in order to permit sideways flushing through the respective layers of slate by means of a hose. After which the capacity was found to have increased to 82 per cent., exactly equal to the original capacity of the new bed as calculated from the quantity of slate used." We all know that the water capacity of an ordinary bed is 33 per cent., and that decreases as time goes on. If Mr. Dibdin can maintain the position at Devizes, then I think we have made a most decided advance. As regards the material for filters, we have now arrived at the conclusion that the material has very little to do with the question, and that limestone or slate will give equally good results at much less cost. I want to say a word as to the use of clinker for filter-beds. Unless properly graded, it is of very little use. I have seen clinker used of various sizes, and the smaller particles found their way into the interstices of the larger material, and the whole thing was soon clogged up. The filter must be made of uniform particles throughout, so that the aerobic action can take place. That is the secret of the whole thing. If you want purification of sewage, you must promote aerobic action, and the experiments of Mr. Dibdin prove that most conclusively.

Mr. Charles Jones: I have pleasure in seconding the vote of thanks to both the Authors of the papers, but cannot quite allow Mr. Dibdin's paper to go by without a little objection. The day has not quite arrived when we can do without sludge pressing. It is twenty years ago since our friend Mr. Dibdin, in reply to a discussion (at the Institution of Civil Engineers), in which I took part, said that the expense of treating the sludge would be something enormous. I refuted the statement then and there, and can only say that from that time to the present I have not altered my system. I have not as much land as the size of half this room over and above my actual requirements for tanks, etc. What am I to do? I have no place on which to form lagoons, and I do not want them because they would not be in existence a fortnight without an application for an injunction. I am obliged to deal with the sludge on the spot, and I think experience justifies me in saying that, surrounded by houses, and with the sewage of a population of 40,000 or 50,000 to treat, we do our work without a shadow of complaint. I burn everything. You know I have great faith in the refining furnace. For the last thirty

years I have burned the sludge in the destructor along with the house refuse, and I am burning it still. It goes into the furnace cell as sludge and comes out as clinker, is then broken up, and afterwards made into slabs to go on the footpaths, miles and miles of which have been paved in that way. I also have clinker for my bacteria beds, so that I use everything—I do not grade my bacteria beds, and I do not believe in grading them. Any of you are quite welcome to come and see what we are doing at Ealing. Sludge pressing is not dead at Ealing, and will not die. The question of treatment must be subject to local circumstances. My experience has fully impressed upon my mind the absolute importance of precipitation before application of the effluent to any form of filtration, whether constant or by bacteria beds. Combined of course with a high degree of oxidation, produced either by natural methods or artificial means, there should then be no difficulty in producing a first-class result.

Mr. A. M. FOWLER: I have dealt with mud at Brighouse in filter beds in the same way as you would deal with pure water. We all know in a waterworks filter the precipitated matter in the water never goes far from the surface—not more than the thickness of a shilling. The mud, when placed on these filters, commences to dry, and can soon be dug out quite easily. Fortunately, I experimented with these beds before we ordered the sludge presses, and therefore saved the cost of them. The manager is delighted with them, and they work easily and comfortably. It must be distinctly understood they are entirely different in their superstructure to lagoons.

Mr. J. LEMON: What thickness of mud do you get on the filter-beds?

Mr. A. M. FOWLER: Six or eight inches to a foot, according to the state of the weather.

Mr. J. S. PICKERING: The conclusions arrived at in the two papers appear to be somewhat conflicting. Mr. Watson advocates the anaerobic or septic treatment, but Mr. Dibdin says that "aerobic methods, unless in very special cases, are not only unnecessary but undesirable." I think Birmingham is one of those special cases where the septic treatment is allowable, and the results Mr. Watson has obtained at Birmingham are a proof of this. Those who knew the Birmingham sewage farm before Mr. Watson took over the charge of it some years ago can appreciate the enormous improvement which has taken place

since the new system was installed. I do not think, however, that, having said so much, we can necessarily copy what Birmingham has done. I believe Mr. Dibdin is working on the right lines in stating that the anaerobic methods are undesirable as a rule, and that Birmingham is one of the exceptions. I have been over a very large number of works where the septic treatment is in operation, and I do not know of an instance where the system is carried out without considerable nuisance. The septic system is essentially a process of putrefaction, and must be a nuisance. It appears to me when Mr. Watson states that there is no offensive odour from the sludge of his septic tanks that he avoids one nuisance by creating another. If he overcomes the nuisance of the sludge, he gets a greater nuisance from the septic tank effluent, particularly when it is distributed in the form of spray. Mr. Dibdin passes over a most important detail in connection with his paper. I understand the system of cleaning at Trowbridge and Devizes is by means of a hose-pipe. It seems impracticable to wash out acres of beds in this manner, and it is for engineers to assist Mr. Dibdin in finding out a better method. Mr. Watson says the liquefaction in his tanks is only 10 per cent., but there is no doubt that in many cases it is much higher than that, particularly when the sewage is of a domestic character. I cannot quite see the object of leaving out the screens and settling tanks in dealing with the sewage, and I hope Mr. Dibdin will give us his reasons for doing so.

Mr. S. H. CHAMBERS: There is very little in Mr. Dibdin's paper that I can agree with. We are told that the London sludge is dealt with aerobically by dilution in the aerated water of the estuary of the River Thames. There can be no doubt that the sludge deposited forms what is described in the second report of the Royal Commission on sewage disposal with reference to the pollution of the River Severn, "an aerobic pool." In the report it states: "We compare the action taking place in these sludge accumulations to that in the septic tank. The mud is black, and offensive gases are evolved." The same applies to any accumulation of sludge whether in pools or beds, and that anaerobic processes are as essentially founded upon simple natural laws as are aerobic processes. As there is some misunderstanding in the meaning of the aerobic action, I should like to have from the Author the precise definition of what he means by aerobic action. In the first account Mr. Dibdin gave

of the suspended matters by the slate beds, he stated that "no suspended matters escaped from them—100 per cent. purification." Now you find that there is a certain quantity of semi-black matter which escapes from them, and it, he says, consists largely of "bacteria, paper, fibres, etc." The experience at Hampton has clearly shown the importance of the etceteras. Our primary beds have been cleaned, and the sludge consists very largely of organic nitrogen. From this experience, I cannot regard any system of treating crude sewage by contact beds, whether slates or otherwise, as at all of the nature of a practical operation.

Mr. R. A. MacBrair: We clean our beds at Lincoln by means of a revolving screen worked by a portable engine. It is really an adaptation of the breaking machinery used at granite quarries. The sewage effluent is brought by wooden troughs on to the top of the revolving screen, into which the medium is thrown. We use the effluent from the first contact bed to wash the medium of the second contact bed, and then, to wash the medium of the first contact bed, we use the tank effluent, which has been settled for a period of twelve hours. A hole is made in the medium, and the plant placed on the floor of the bed, and worked across it, the medium not being removed from the bed. When a bed is finished, it is found best in several ways to run the plant through a gap in the wall of the adjoining bed, and so on, instead of hauling it up, and beginning *de novo* each time. The cost of doing this is 8*d.* per cubic yard; adding the cost of supplying material to make up for that lost in the process brings up the total to 1*s.* per cube yard.

Mr. J. P. Wilkinson: We at Manchester are doing something in the way of washing our bacteria beds, and we find the cost is 1*s.* 6*d.* per yard, including the renewal of material. I have spent a good deal of time and trouble in trying to devise some system for the washing of the material *in situ.* We have come to the conclusion that the best thing is to take the material out, wash it at a central station, and put it back. One thing that weighed with us very materially was the difficulty of getting away the wash water, and dealing not only with the fouled water, but the enormous amount of matter in suspension. By our present method we run our wash water back into the tanks, and it goes through the ordinary process of treatment there. What we do is to put the fouled medium from the contact beds

into what is vulgarly called a jigging screen, which throws the larger things forward and puts the finer stuff through the screens in different grades. We find in that way we have a loss of 30 to 40 per cent. of the material. We find, however, that 10 to 15 per cent. is available as a finer medium for second contact beds, which, of course, somewhat reduces the cost of washing. Mr. Dibdin tells us that chemical treatment and sludge pressing may be considered matters of ancient history. I am afraid that statement is rather premature; at any rate, it is subject to a considerable amount of qualification. It may be true in some cases that chemical treatment and sludge pressing are matters of ancient history. I could mention cases in which chemical treatment and sludge pressing are an absolute necessity. In the first place I should submit very respectfully to Mr. Dibdin, as a chemist, that where sewage is fouled to an inordinate extent by chemical refuse, chemical treatment is almost a *sine quâ non.* Chemical treatment does afford facilities for obtaining a clear tank effluent in advance of any other method. I should like to emphasise another point—that the crux of sewage purification apart from sludge disposal is almost entirely a question of tank effluent. The better your tank effluent the better will be the ultimate percentage of purification. I do not care what methods of treatment you adopt. Mr. Collins has pointed out that the same thing holds good of land treatment. Put on your land a good tank effluent, and you will save your land and get a good effluent. In many cases a single filter-bed is sufficient, and Sir Henry Roscoe has proved that with his filters. One other point—it may sound heretical — but I wonder whether it matters from the point of view of cost whether you adopt chemical treatment or double contact beds? Supposing, for a moment, that at Manchester we are likely to wash out our beds every five years, that roughly means 10 acres of beds per annum. If you take 10 acres of beds per annum, and assume each acre contains 5400 cubic yards at 1*s.* 6*d.*, you get something like 400*l.* per annum per acre for washing out and renewal of the beds. If you multiply that by 10, you have 4000*l.* per annum on the total acreage of the Manchester beds. If you are going to spend 4000*l.* per annum in the cleaning of beds, it seems that there is not very much to choose between that and the spending of 2000*l.* or 4000*l.* in obtaining a really good chemical tank effluent. That is a matter which I submit with

diffidence. With regard to sludge pressing, I remember going in 1887 to see Mr. Jones' works at Ealing. I was much impressed, and am very much interested to hear it is going on still. Whether he can always rely upon doing that I cannot tell. We in Manchester are very favourably placed, as we carry our sludge to sea and have done with it. I agree with Mr. Watson that for the removal of the grosser suspended solids, the inverted pyramidal form of tank is perhaps the best possible method of dealing with the sludge. We have a similar method of dealing with it at Manchester. Our screening machinery has cost us a large sum of money, and I have never thought the results quite commensurate with the expenditure. I think that our output from the screening chamber is 50 tons a week. Now, 50 tons a week does not seem a very large volume to take out of 26 million gallons of sewage a day. And, as a matter of fact, we find that a very large portion of the suspended matter is taken out, not in the screening chamber, but in the detritus chambers, which are fairly efficient. They are somewhat larger than the figure Mr. Watson gives of 4000 cubic feet per million gallons of sewage. I think our detritus chambers are 10,500 cubic feet for a flow of 1,500,000 gallons. One little matter that rather puzzles me is that Mr. Dibdin describes the slate contact bed as being the aerobic method. I am in doubt where the dividing line comes in between the anaerobic and the aerobic methods of treatment. The method of superposing surfaces in practically close contact or within a very small distance of each other is one with which I thoroughly agree, and I agree with it rather from a point of view which has not been touched in the paper, and that is the attraction by larger bodies of smaller bodies. It was brought to my notice many years ago by a member of the Manchester Corporation, who was a brewer, and who used to urge very strongly that our precipitation tanks were too deep, and that we ought to have a wider area and much less depth, when we should get a much better deposit of solids than with tanks 6 ft. or 7 ft. deep.

Mr. W. J. Dibdin: I am very sorry there has been a little misapprehension of the sense in which I used the words "ancient history." I did not mean to imply that in every and all cases chemical treatment and sludge pressing are perfectly useless, but that it would be perfectly useless for me to say anything about it, because I thought there was nothing new to be said.

I do not mean to suggest that in no case can they be of any use.

Mr. G. W. LACEY: As to the disposal of the sludge and the preliminary treament of the sewage, that seems to be a great stumbling-block at the present time. There are difficulties with the septic tank in keeping the sludge in for months or years, and also difficulties with the smaller sedimentation tanks and removal of the sludge at more frequent intervals. The question one would like to solve is, which is the better system of the two. It is a question which exercises many of our minds. If you remove at more frequent intervals, you will only get more water with the sludge. Even if you run the tanks for a longer period, you have to set against that the nuisance and inconvenience of having to deal with larger quantities of sludge. It depends upon circumstances as to how you can dispose of it. The utter lack of manurial value of the residuum from the septic tank has been made clear. It is probable that if tanks were emptied earlier there would be greater manurial value. With regard to the use of slate beds, it is quite an interesting departure. No doubt all methods of bacterial treatment require a longer period than fourteen months before we can altogether attach credit to them. I see that, in the fourteen months the Devizes bed was in use, there was a loss of capacity of 37 per cent. It does seem to me that on a large scale there would be considerable difficulty in the washing out of these slate beds, because in every place you cannot get the force of water to effect that operation. You want a considerable pressure to wash out a very large bed. It seems that the bed constructed of slates is acting very largely in the same way as a sedimentation tank. I do not know whether the report of the Royal Commission will help us very much to a decision. I hope it will. They have certainly given a long period to their investigations, and we can hope in a few months to have it published. The Royal Commission has had the Oswestry works under observation, and it has been proved very accurately that the life of the bacteria beds as worked there, cannot be placed at longer than five years. That is the efficient life. They can be driven on for longer, with diminishing results.

The vote of thanks to the Authors of the papers having been accorded,

Mr. J. D. WATSON, in reply, said: I have listened to the various speakers with very great pleasure, and I think it has

been shown that both Mr. Dibdin and myself have chosen the right subject to provoke discussion. You will all observe that neither of us said anything about the ultimate treatment of sewage on bacteria beds whatever their form. We have both dealt with the question of sludge, which we feel is the most important and difficult question to deal with at the present time. The ultimate or nitrifying process is very largely a question of money. In the case of sludge it is a question of obviating nuisance, and I am not at all surprised that my friend Mr. Cooper took up the attitude he did. He seemed perfectly incredulous that it was possible to deodorise sludge, especially where there was a very large bulk of it. If Mr. Cooper had said three years ago what he said to-day, I should have agreed with every word. No one was more surprised than I was to find that it was possible to reduce sludge to an inodorous state. Mr. Pickering raised a very proper question when he said that by reducing the sludge to an inodorous state you may promote a more septicised sewage than is desirable, and you may be defeating one of your objects and rendering the oxidising process more costly. I think there is a very great deal in that remark, and I am bound to say I have experienced the objection of sewage being over-septicised. This can be avoided to a very large extent, however, and to get rid of the sludge nuisance, some sacrifice may have to be made. Since our large tanks have been in operation as septic tanks—and the great sewer, which has a capacity of over six million gallons, has been reckoned as one of the septic tanks—the normal flow may be said to be in a state of fermentation for eighteen hours before it is applied to the bacteria beds. On Sunday when the flow is less the *rest* is longer, and we find over-septicised sewage on the Monday morning. That is a subject which still requires close investigation. We have nearly 3000 acres of land, and yet bacteria beds are necessary. When you realise that the Birmingham works are dealing with a population of 900,000 and that we have only 2800 acres in our possession altogether, you will see it is absolutely impossible to go on without augmenting the means of purification. We would require to buy nearly two acres of land every week if we were to keep pace with the present increase of population, and that is practically reducing the proposal to stick to land only, to an absurdity. I began by saying that I was dealing with a sewage of which I gave analysis. I have dealt with other sewages and have found considerable

difference between one and another, and the purification results were correspondingly different. Mr. Wilkinson has given us some most interesting facts regarding the cost of freeing sludge from contact beds. I am glad to know the cost of cleaning the material at Manchester. I was also interested in hearing that he expected to have to clean it every five years, and to hear that the material lost 30 or 40 per cent. of its original bulk in the process of being cleaned. Those are interesting facts, and ought to help us in the elucidation of this complex subject. I cannot quite agree with him that where you have large quantities of trade waste it is essential to use chemicals—but this is somewhat foreign to the subject of sludge treatment. We do not use chemicals, although we have a very large variety of trade waste; and with a sewage having an average annual oxygen absorption figure of 30 parts per 100,000 that is *primâ facie* evidence that you can do without chemicals. For many years we used lime, but for five or six years we have found no disadvantages, but many advantages, in not using any lime. One of the advantages is that we can treat our sewage naturally, and get an effluent which is more rapidly nitrified than if we were using a chemical which must, in the necessity of things, precipitate with the sludge the very organisms provided by nature to complete the work of purification.

Mr. W. J. DIBDIN, in reply, said: The first thing I have to do is to thank you very heartily for the kind, appreciative, and sympathetic manner in which you have treated my paper. The general trend of the paper has met your approval, and in that I felt that my efforts had not been thrown away. First of all, I should like to thank Mr. Pickering, who struck a very material nail very squarely on the head when he made the remark that it is for engineers to assist the chemist in overcoming mechanical difficulties. There is the essential keynote of the whole story. I naturally, when at my laboratory bench and microscope, both see and imagine many things, and many of those things may lead to good conclusions or only give me general ideas, but so far as possible, I try to sift the good from the bad and then try to put those principles into practice. But it must be obvious to everyone, that when you come outside the laboratory, you have got to deal with vast quantities of water and solid matter, and there are mechanical difficulties to be met. I cannot pretend that we have attained perfection, and I do

not know when we are going to get perfection in sewage treatment. The remark was made that "we could not expect we were going to treat sewage for ever and ever for nothing at all." Therefore whatever scheme we adopt we must be prepared to meet with difficulties and overcome them. Colonel Jones has made the remark that the sooner the matter is disposed of in the earth the better. Perfectly true, and the sooner we can get it in that condition the better, and that is the object of bacteria beds. I laid it down in the first instance that the bacteria bed was nothing else but artificial land. That was the original idea, that you could do on one acre that which you had had to do on many acres of land. I laid that down as Nature's method, so Colonel Jones is quite with me. Mr. Cooper made some pithy remarks to the effect that I was going back to land treatment. There he made a mistake, because the bacteria bed is land, and Nature's method; and instead of "going back" I am standing fast. The sludge difficulty I have tried to meet by bringing about as much aerobic action, in the destruction of the nitrogenous matter, as possible, and that is the object of the slate bed. If you destroy the nitrogenous matters you will destroy the offensive matters, and leave a portion of the carbonaceous and the mineral matters. That is what Mr. Watson is doing to some extent at Birmingham, and thereby minimising the nuisance from sludge. The remarks made by Mr. Lemon were extremely gratifying, and showed such a clear appreciation of the views I desired to put forward that I felt extremely encouraged to continue on the lines on which I have been working, and his conclusion that whether on land, in tanks, or in bacteria beds, you must facilitate aerobic action, sums up the whole thing. Mr. Charles Jones still burns his sludge. But to apply that as a general principle to the country could not be recommended. I have burnt many hundreds of tons of sludge. We tried if that would be the most effective way of getting rid of the London sludge, but had to give it up as being too great a nuisance and expense. The practice of burning sludge is hardly one that will become general. Mr. Fowler has described his filters at Brighouse, which have saved him the expense of pressing. That reminds me of an experience at Crossness. We there laid the sludge out on artificial beds 6 in. deep, where it dried and cracked in the same way as at Brighouse, and we came to the conclusion that in small works it would do well instead of pressing. We had several presses ; one 5 ft. in diameter. The net result was

that the cost per ton of cake came to *4s.* *6d.*, and as we found we could throw it away in the estuary of the Thames at *4d.* pressing was abandoned. The whole of the sludge of the London sewage—over 40,000 tons a week—is disposed of in the aerated water of the Thames estuary without the slightest fear of nuisance. When the vessel is ten miles out below the Nore the valves are opened, and 1000 tons of sludge are turned out over a course of 10 miles. The effect is that you see the water darkened a bit in the wake of the vessel, and when you turn back you cannot see a trace of it. As it is deposited in a channel a mile wide, 80 ft. deep, and churned up by the screws of the vessels, the possibility of the sludge settling down and undergoing an anaerobic condition is very remote. I have spent weeks dredging that channel and taking samples, and have never found a trace of that sludge. My successor, Dr. Clowes, has also done the same, and could not find a trace of it.

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NOTES ON THE CARRYING OUT OF PUBLIC WORKS DEPARTMENTALLY.

By A. H. CAMPBELL, M. Inst. C.E.

It is scarcely necessary to state that by this title is meant the execution of public works by labour employed directly by the local authority. E

This question is one much to the fore at the present time, and the following notes are put forward more with a view to promoting discussion upon a subject which has not heretofore found a separate place in our proceedings, than as an exposition of the virtues or the vices of this system.

That the Annual Meeting of Municipal Engineers is a proper place for some official pronouncement on this matter of public policy cannot be questioned. The vast annual expenditure on local public works—for the design and construction of which the Members of this Association are in the main responsible—and the various views held by different authorities as to the best method of carrying out such works, entitle this Association from its most intimate knowledge of the subject, to be a fit vehicle of official opinion as to this question of public policy.

Recent decisions, moreover, of the Local Government Board in their sanctions to loans, seem to call for consideration. Without referring to individual cases—which in this paper would be obviously indelicate—the Author would submit in general terms those objections which the central authority have recently raised when sanctioning, or, it may be, withholding sanction, to loans. These are as follow, viz.:—

1. That excess expenditure incurred beyond that for which a contractor might reasonably have completed the work, is a proper surcharge upon the authority carrying it out.

2. That no payment out of borrowed moneys should be made

to any salaried officer of the Council, save, under certain conditions, the clerk.

3. That the wages of any permanent staff or workmen of the authority should not be charged against the loan, although such workmen and staff may be solely engaged upon the work for which the loan is sanctioned.

Strictly interpreted and applied to local life, those conditions of sanction seem to preclude the carrying out of works by direct labour, or at least to put across its path such barriers as make its progress difficult.

Looking at those objections in their order, the first mentioned —that of surcharge—imposes upon the local authority a risk which they are hardly likely to accept, either in their individual or their corporal capacity. It says in effect, " Do your works by what method you care, but understand that if public money is lost by the policy of direct labour, such loss will be surcharged upon the authority."

Surcharges are the pin-pricks of public life, and it is well to avoid them. Whether intended or not, this decision operates as an almost effectual deterrent to the policy of direct labour, especially where the elements of risk apply. Now, be the policy a good or a bad policy, direct labour has in many cases justified its existence, although, doubtless, there are cases where failure has resulted.

The conditions, therefore, that make for success, and *vice-versâ*, should be examined, and these the Author would state as follows:—

1. That for any work about to be undertaken by direct labour under " sanction," the estimate of cost should be tested *by the estimate of another expert.*

2. That in the actual carrying out of the work, the same system should apply as between the engineer and his resident agent, as would apply were the work the subject of a contract; that is to say, the rules which regulate the carrying out of public works' contracts should apply to the policy of direct labour, monthly measurements being made by the engineer of the value of works executed, and that he certify to the authority as if in the case of a contractor.

3. That in the execution of the works, the engineer or manager be granted a free hand as regards (*a*) purchase of materials at the lowest market prices; (*b*) as regards employ-

ment and discharge of labour; and (c) as regards the administration of all details.

The system of monthly measurements of work done, will prove an effective check during the progress of work as to whether the authority, as direct employer of labour, is holding its own in the matter of cost.

If profit is being made, all is well; if loss, then the sooner the authority knows it the better; the submission of those monthly statements of account is one of those duties not always pleasant, frequently irritating, sometimes cheering, but whatever be the state of account upon any work, it should be disclosed to the authority at the earliest possible, and if upon the losing side, then such checks should be applied as will prevent further loss, and lead to the possible recovery of that already suffered.

In cases known to the Author, had this strict system of surveillance and proper monthly certification of work done under direct labour been applied, much ultimate trouble would have been averted.

It is further essential at the outset of any work to be done by direct labour, that an analysis be made of the estimated value of materials and of labour for each separate section of the work, that is to say, for each distinct trade, and the monthly valuation reduced to this code of comparison. Such analysis will reveal upon what section of works profit or loss is being made, and at the end of a work the resultant gain, or the reverse, over the completed work.

All this involves much labour, anxious research, and persistent vigilance; the aphorism, "No pains, no gains," finding singularly full illustration in the carrying out of this phase of municipal trading.

A further factor determining the success of this policy, is the hearty and substantial backing of the public authority. The Author would not say "unanimous" backing, for, in the composition of a council, unanimity is not desirable; but, certainly, the policy of direct labour demands for its success, the confidence and enthusiasm of such a substantial majority as will, in numbers and intelligence, fairly represent the sentiments of the authority, and that still stronger sentiment of public opinion behind the authority.

"A house divided against itself cannot stand," finds its truth in the pursuit of this policy, and for illustration one has

only to recollect the chequered career of the Works Department of the London County Council in its early days. Until the party supporting this policy obtained at the polls such pronounced ascendancy, the Works Department scarcely realised security of existence. Since the composition of parties has changed, and apparently so for a long lease of power, the Works Department has prospered—that is to say, along lines which, if not liberal, are certainly fair to the Department, and which, if copied by other authorities, might produce like results.

These are the following:—

1. The Works Department does not tender in public competition with contractors, but its tender is based upon that of the chief engineer or superintending architect of the Council.

2. The Department is allowed fairly free scope in its arrangements with labour, by payments for work done on the "bonus" system. This acts as an undoubted spur to the men in the diligence of their daily work and their individual out-put.

3. The Department, in the carrying on of its work along those lines, is the expression of the people's will. So long as it enjoys that support, it should continue to prosper. Change the composition of the Council, then may come the imposing upon the Department of tests that irritate, and of conditions that may kill.

The Works Department of the London County Council has been selected, because it is the first authority in the country, for the magnitude and probably continuity of its constructive necessities. They are undoubtedly the leading exponents of the policy of direct labour, generously applied, and with results which, in the quality of its workmanship, cannot be surpassed.

Mention might be made of other municipal authorities upholding this policy, but beside the London County Council, there is but one other in this country known to the Author which maintains a specially constituted and separately formed Works Department, that is to say, distinct from that of the engineer's department. Suffice it here to say that its separate existence has not been a happy one; what remains is suffering from starvation of work and consequent gradual extinction, because it cannot survive the ordeal of competition by public tendering.

One other city of size did attempt a separate Works Department, but as such it had a very brief existence, and is now remerged as part of the engineer's department.

Local authorities should remember there is but *one* London, and what its County Council can do by the magnitude and the multiplicity of its works constantly "on-the-go," other Councils, necessarily restricted in the output of their works, cannot copy.

Objections 2 *and* 3 *of the Local Government Board, viz.*: "Any payments out of capital accounts to any salaried officer," . . . . "or as wages to any permanent workman" of the authority, seem to preclude altogether the possibility of separate existence of a Works Department, unless such salaries and wages are to be paid out of revenue account.

The Author is aware how repugnant objection No. 2 is to this Association, but this objection now extended to the permanent workmen of a municipal Works Department practically makes, or has the effect of making, the payment of wages to any permanently appointed works manager out of the proceeds of the loan illegal, and it precludes the payment of wages to workmen who, independent of any particular work, would be permanently employed by the local authority, such as foremen, or leading hands.

This last named application to the wages of permanent workmen is a new decision of the Board, and is one of possibly far reaching importance considered in its relation to this subject. If it does not expressly veto the direct employment of labour on municipal and public works, it will tend to cripple the policy and hinder its progress.

Those recent decisions may be taken as straws indicative of the current of official thought on this matter, and invite us to examine, wherein lie the relative merits, or demerits, of the whole policy of direct labour.

As to the origin of this policy, precise record is difficult to trace, but the Author recollects the controversy in London, now some twelve years' old, when suggestions of a "ring" to keep up prices inspired the County Council in retaliation to adopt the policy of direct labour.

As a way of meeting and combating, possibly, dishonest trading combination, undoubtedly direct labour is a sure defence. From that origin has sprung the County Council's Works Department as it is to-day; and as the living embodiment of the well-settled policy of the County Council, it has achieved a great measure of success, favoured by the conditions which regulate and foster its existence. The lead of the County Council has

been followed by many authorities in the country, so that now this system is practised in greater or less degree in the provinces and in the metropolitan borough councils.

That it has merits is unquestioned, and probably unquestionable; that it has risks is just as true as that contractors do sometimes fail and become bankrupt. Of course the discouraging element of "risks" may be toned down, if all works of a risky nature are let out to contractors, reserving for direct labour only those works unattended by any "risk." The "whole hogger"—if one might coin a term from another topic to describe the out-and-out enthusiasts of direct labour—sticks up for his idea on the sole ground that it is either a right policy or it is not, and by its own inherent virtue or iniquity it should stand or fall.

With this sweeping dictum the Author does not agree. If it is to continue a part of the policy of municipalities of this country, its field of operation should be selected in favour of those works which do not involve the provision and purchase of such plant as it is probable the same district will not require again, but to such works as can readily be carried out without great establishment charges. Further, the building up of a great contractor's business, minus a contractor's scope, and without the guarantee of continued use of the plant, is likely to be a burden and charge which will rob direct labour of any profits that may accrue to it from the simpler works it can profitably carry out. It will thus recoil upon the too enthusiastic supporters of this policy, if pushed to its illogical conclusion.

In most towns municipal work is necessarily limited, and subject to the fluctuations of periods of activity and the reverse. There cannot always continue the constancy of constructional works; the ratepayers must have time to digest the debts of municipal activity; so that, again, a department specially dependent upon new constructive works, and limited to one town or district, suffers by those recurring periods of depression in public expenditure.

The ideas animating this policy, viz. (1) the saving of money, (2) the insuring of satisfactory workmanship, and (3) the work being done under fairer conditions of labour, deserve consideration here.

The Author, from very considerable experience in the carrying out of works by direct labour, cannot claim that the first

has been realised to any encouraging extent; he admits the second, and the third idea is possible to both systems. It is a matter of simple arrangement, either under the policy of direct labour or contract, that is to say, that any special conditions of labour desired by a local authority can be obtained by stating them as articles in the contract.

Incidentally, other advantages claimed for this policy are the saving of those "bills-of-extras" that are the bugbear of many contracts, and the nightmare of engineers; likewise it offers facilities in the carrying out of any work, for modifications to be introduced without the inevitable sequence of adjustment of accounts arising out of such modifications. Inasmuch, however, as any proper system of contract or direct labour requires the strict keeping of account, and final adjustment, those incidental advantages are more fanciful than real, and they are not sufficient to decide this question.

One argument in the mouths of supporters of the contract system is, that they know when the work is started what it is going to cost. If a loss occurs, it is the contractor's loss, and the ratepayer is safe. This argument is a plausible one, and, with Councils, it necessarily goes far in the favour of the contract system. It forecasts the issue of any public works, by so carefully and cautiously counting the cost before incurring expenditure.

It is only right that it should be so, and to this very pertinent objection, direct labour must answer. Such answer can only be the facts of experience. Has, or has not, the past experience of direct labour justified the measure of risk involved in the policy of direct labour?

This question, again, must be answered by each authority according to the light of its own individual experience, and, where this is not available, by the light which others may shed.

It may, however, be premised that contractors, capable and resourceful as they are, do not dispense philanthropy as a part of their going concern; they are like the dyer, who advertises his calling by proclaiming that "he dyes to live, and he lives to dye." So the contractor lives to profit. Whilst the balance of his business is, as a rule, fairly profitable, there are the occasional risks, at times so great that he comes to bankruptcy. In deciding, therefore, upon the question of "risk," one has to regard the nature of work, the degree of risk attending its exe-

cution, and whether past profits, if any, justify the contingency of loss, as the final result of any particular work.

This loss will have to be made up somehow, and if there is no reserve fund to draw from, and the capital sanction has been expended, whence is it to come, if the Local Government Board are to enforce their latest decisions with respect to the "surcharge of excess expenditure"?

It appears, therefore, that where works departments are already established, any profit that is made on individual works should go to the formation of a reserve fund, to balance possible losses on other works, and until such a fund is well established, it would appear imprudent to undertake further works by direct labour, where there is the probability of risk.

The nature of works suited to direct labour is worthy of study. The works of any local authority are made up of two heads:

A. Maintenance.
B. Constructive.

Under the former are included:

(*a*) Highways' repairs as distinct from renewals.
(*b*) Sewers' maintenance.
(*c*) Corporate estate property repairs.

As these maintenance works are generally executed by the permanent staff of the local authority, and could not well be competed for; they are, without doubt, proper subjects for execution by the Council's own working staff of the engineer's department.

They do not involve the provision of much plant.

It is under the latter head—namely, that of "constructive works"—where the controversy begins, and therefore, considerable diversity of practice.

As applied to the works of a municipality, these comprehend in their nature, the following:—

(*a*) Buildings.
(*b*) Sewers and disposal works.
(*c*) New roads.
(*d*) Tramways.
(*e*) General street works, cabling, street widenings and improvements, pavings, and private streets formation.

(*a*) Dealing with this description of works, the first named,

i.e., new buildings, do demand the purchase of considerable plant, and previous technical skill, and unless a reasonable chance of work can be guaranteed for the maintenance of such plant, this must be looked upon as speculative and risky in its nature.

(*b*) *Sewers and Disposal Works.*—Whether this is a work of risk or not, is very much a matter of degree. For ordinary branch sewers of shallow depth and small size, there is not much risk attending the work, and as it does not involve the purchase of much plant, it is a work, from a financial point of view, that may safely be undertaken by any local authority so disposed. It is in the construction of large arterial sewers at great depth, and probable treacherous strata, that risks abound. This work further requires the purchase of special plant, and as such, unless other considerations prevail in favour of direct labour, it is not the kind of work conducive of profitable return to any works department.

(*c*), (*d*) and (*e*) *New Roads, Tramways, Street Works in general.* —These works are all superficial, and do not involve the purchase of plant, nor are they attended by risk, and are therefore suited, from a constructional and financial view, to be carried out by direct labour.

The Author is much indebted to Mr. Norman Scorgie, M.Inst.C.E., Borough Engineer of Hackney, for a copy of replies to a series of questions addressed by him having reference to the establishment of a works department.

As regards the Constitution and Management of Works Departments, the Author finds that in twenty out of the twenty-one cases where works departments exist, the engineer is the chief official responsible for the administration of the department.

In every case out of the twenty-one boroughs returned as having a works department, the engineer's estimate is taken as the basis of cost, and the final cost compared with his estimate, subject only to the cases of Battersea and Woolwich, where for important works of magnitude, the engineer works upon an estimate of cost prepared by a quantity surveyor. Only in very exceptional cases is he required to tender in competition with contractors. The return compiled by Mr. Scorgie shows that in only one or two cases is this imposed, so that the general practice is (1) the engineer's estimate taken as a basis of cost, and (2) it is accepted by the authority without competitors.

The Author inclines to the opinion that it would be better, in order to silence the criticisms under this head, that in every case where works are of any size, an independent quantity surveyor should be appointed, (1) for the purpose of preparing the works estimate upon the engineer's plans, and (2) for official certification of account of work on completion.

Generally speaking, this return further shows that the field of operation of works departments is restricted to highways and sewers construction, works of the building nature being let out to contractors, save only in the following five cases, viz., Battersea, Poplar, Woolwich, West Ham and East Ham, where buildings are largely undertaken by direct labour.

The Author is supported by this recent return in the opinion expressed earlier in the paper, viz., that as a general rule, the sphere of municipal works departments should be defined in their operations, and that the most suitable description of works to place with them is (1) the formation of new streets, (2) the laying of contributory branch sewers, and (3) generally such works as being upon or near to the surface of the ground, do not involve the purchase of plant upon a large scale. Not that a works department cannot successfully execute any of the list of works enumerated herein, under the head of constructive works (for the Author's personal experience is that it can, and this under severe test conditions), but that the conditions generally under which such a department is permitted by local authorities to operate, and amidst the contention of opposing parties composing those bodies, it is not expedient that the policy of direct labour, good in itself, yet so difficult to work, should imperil its credit by entering upon works of a difficult and dangerous nature, from which, even if it should emerge successfully, it will probably receive no credit, and if it do not, it will be damned.

The Author would here explain the constitution of the works department under him. The engineer is responsible to the works committee for the employment of men, and for the work done. The engineer pays no accounts (the borough treasurer doing this); he orders all the necessary material direct from the merchants, these materials being either the subject of annual contracts, or of special quotations. The men's time is taken by an independent officer, called the timekeeper, and the stores are issued by the storekeeper. They

are both officers of the treasurer's department. The treasurer is the official recorder of prime costs. A fairly free hand has been allowed as regards the details of administration: the reports to the works committee consisting of requisitions for necessary materials, statements of men employed, and progress reports of the works in hand; the statement of expenditure being reserved until the completion of the work, when the treasurer submits his financial statement of the cost.

The system of having the timekeeper and storekeeper distinct from the engineer's department is a good one, as it insures independent record of time, stores, and materials, upon every work. Those officers report direct to the treasurer of the Council. There is thus no possible ground for questioning the authentic records and returns of costs by responsible and disinterested officials.

As regards establishment charges, this necessarily varies with the magnitude of the works in hand at different times; thus, the greater the amount of works, the lower the percentage of establishment charges, and *vice versâ*, but the average is generally reckoned at 10 per cent., and every work undertaken becomes subject to this charge.

The value of new constructive works, beyond those of contracts, undertaken by direct labour during the last six years upon lines as above described, amounts to fully 300,000*l.*, and comprise in their nature the following, thus:—

	£
Tramways	45,000
Buildings	82,000
Street widenings and improvements	47,000
Private streets formation	97,000
Sewers and sewerage	33,000
Parks and miscellaneous	11,000
	£315,000

The variety of works here shown has enabled the Author to test this question and policy under all conceivable conditions.

That the responsibity of such a department carries with it tremendous anxiety is admitted; not so much the work itself, as the worries inseparable from most public positions; and it is questionable whether municipal engineers should encourage this policy beyond a certain limit, unless their remuneration is upon a scale commensurate with the responsibility. This responsibility is of a two-fold character, viz.: (1) the engineering, and

(2) the contracting, and both positions involve and demand much professional skill, and the practical commercial instinct.

On the whole, it were well that the members of local authorities should be more united in their definition of the scope of this phase of municipal trading, and in a spirit of unity and loyalty, back it up with all their might, trusting their captain-in-command. Then, with the scope of operations once strictly defined, and working along lines laid down, it may grow in strength, and show itself as a policy of practical utility, and not the mere play-toy of the faddist, as it is sometimes derisively called.

Of course, in the further pursuit of this policy, local authorities and their officers cannot be blind to the recent deliverances of the Local Government Board bearing upon this subject. These must exercise a restraining influence in the free scope and expansion of the policy which it has been the purpose of those notes to review in all its bearings.

DISCUSSION.

Mr. W. Harpur: The methods by which the Author carries out his works at East Ham, are very similar to my own at Cardiff, when undertaking works of this description. There is, however, one point in the paper to which I should like to refer. "One argument in the mouths of supporters of the contract system is that they know when the work is started what it is going to cost." Now I contend that it is not known, when a contract is let, that the work is going to be done for the amount of the contract or anything like it. So there is no more speculation in doing the work by a Works Department than by a contractor, who knows how to wriggle out of his contract, and to pile up extras, and I am therefore in opposition to those who think that because a contract is let for a certain sum the ratepayers know what the particular work is going to cost them.

Mr. T. W. A. Hayward: I should like at the outset to correct one statement in the paper. In referring to Mr. Scorgie the Author says that in all cases of building work the estimates are prepared by the engineer. That is not the case in Battersea, I am pleased to say. In Battersea, if a building job is unusually

large, the Council employ an independent quantity surveyor to prepare the estimates, and I think that is a very good plan, because we are always able to make a larger profit than when the quantities are made out on our own estimate. Mr. Campbell sets out three conditions which make for success. I do not altogether agree with him as to the first, "that for any work about to be undertaken by direct labour under 'sanction,' the estimate of cost should be tested by the estimate of another expert." I think you might go on getting as many estimates as you like and no two of them would agree. I think that opinion is fortified by the fact that if you turn up published tenders for any public job, the lowest tender is only about half that of the highest tender. If contractors vary so much in their prices, how can anyone expect that one, two, three, or four experts can agree on a price? We should simply get our committees in thicker fogs than we do at present. My idea is that the surveyor should keep a record of prime cost. That is the best basis on which to prepare further estimates. With the second condition I practically agree; also I agree with the third, and would like to emphasise it very strongly. If the engineer has to give way to his committee on the purchase of materials and very often pay more than he would otherwise do, he cannot always be expected to bring the cost of works out on the right side. To obtain a free hand is a difficult matter in a democratic borough. Then, following the same principle, I cannot agree with Mr. Campbell when he says that in the carrying out of works by direct labour he cannot claim that money has been saved to any encouraging extent. As to the third reason for direct labour, it is generally the case that the work is done under fair conditions of labour. I agree with Mr. Harpur that the employment of a contractor will not guarantee us against loss or extras. Mr. Campbell makes a pertinent remark when he says that "contractors, capable and resourceful as they are, do not dispense philanthropy as a part of their going concern." I cannot agree with the Author when he says that he does not believe buildings are the proper thing for an engineer to carry out by direct labour. My experience is—and we have carried out buildings to the extent of nearly a quarter of a million sterling—that buildings are the most profitable and the least risky. I should put buildings in the forefront of works that can be carried out by direct administration with success. With regard to the system of employing the timekeeper

and storekeeper distinct from the engineer's department, I think the borough engineer should have control of all workmen in his department. In regard to the percentages given in the paper, I wish I could always get 10 per cent. for establishment charges. We have to be content with 5 per cent., and we find it pays us very well indeed.

Mr. H. J. CLARSON: The sooner the Local Government Board regulation that any money that is paid to the engineer who is in receipt of a salary shall not come out of a loan, is altered, the better. With many small authorities, where the engineer is not able to fight his own battles, he is very diffident in carrying out work, without calling in the services of some eminent engineer. What does that mean? The authorities are allowed to include in the loan they borrow any reasonable sum to pay for the services of this outside engineer. The engineer to the local authority has to do extra work for which he gets nothing, and he gets no experience in the execution of works of that character. In my own case, I was told by a Local Government Board auditor, "In future when you have work of this sort, and you want to save me trouble, get your Council to raise your salary, if only for a month." Was not that a very undignified position in which to be placed, that they should descend to the subterfuge of raising the official's salary, because they could not allow him to go without some extra remuneration?

Mr. W. NISBET BLAIR: It is suggested by the Author, very properly, that a workman employed by the Council should be paid the regular rate which applies for the district, which is generally called the trade union rate. But we do not always secure that the workmen in the employ of a corporation do the same amount of work as men working under the stronger domination of a contractor and his foreman. There is a tendency to "go easy," and it is often encouraged by some of those who ought to give us very strong and zealous support when we are undertaking work on their behalf. There are representatives of the workmen on our councils pretty well everywhere, and in some instances these very members are really urging the workmen to "go easy." That opens up another danger. The establishment of these large works departments is really, under present circumstances the preparation of a huge voting machine. If all employees of local authorities had to sacrifice, in taking employment under that authority, the privilege of their vote, there would

be less reason to find interference in the control of an engineer over his staff. There is no doubt whatever that pressure is brought to bear on engineers, and those who may directly employ the men, assistants, and foremen, and that they are desired to get employment for this man or that man, that the speaker has known him for so many years, and he is a very good fellow. That influence will never be avoided so long as these large bodies of men, 2500 at Sheffield, something like the same number at Battersea, 5000 or 6000 in the employ of the London County Council, are voters. So long as the present conditions exist we cannot hope to attain the same results as would be obtained if an absolutely free hand rested in the engineer, and he had the same means of obtaining the same type of workmen as the contractor had. His authority must be so complete that any man could be paid off at an hour's notice, or whatever the proper notice might be, without any appeal to a committee. There is no doubt the cost of work varies very much in different parts of the country. I was amazed when I came to London to find some of the most ordinary occupations, the laying of York flags and granite setts, cost practically double what it did in Liverpool. There is no reason for that except the principle of "go easy." I agree with the suggestions in the paper. All the three suggestions are very desirable. But there are points to which objections may be raised. With regard to the purchase of materials at the lowest market price, I find that auditors are distinctly hostile to that principle. The auditor likes everything in annual contracts, but in making annual contracts you cannot always do so at the lowest market price. If you are met with objections from the auditor, and have to give involved explanations of why you paid more one month than another, it causes annoyance and difficulty. If you make a contract for timber for a year you get the timber at the same price throughout the year: you may have to pay a little more one month than market price, but you get it cheaper another month. Also in the matter of cement. The contract is cut as fine as the contractor can do it, and he may at times have to sell it at less than he otherwise would. So I do not think there is much in having a free hand to buy materials at the lowest market price. My experience has been to prefer the contract system, so far as you can make it apply. This principle of direct labour is certainly most valuable to a corporation in those many minor works, the repairs of streets and sewers, which

are almost impossible to fix by contract. The ordinary reconstruction of a street or sewer can be more economically done by a local authority by its own men than you can do it by contract. I disagree with Mr. Hayward as to building. The local authority has not anything like sufficient buildings continuously in progress to find employment for a workshop staff. To do this work you require properly equipped workshops, fitted with machine tools, which if not constantly employed are losing money. Therefore I should prefer that buildings should be carried out by contract. In the case of an honest contractor, you can get good workmanship. It does not pay to put in bad work, because he might have to spend more in taking down that which was found defective. Of course you would employ competent supervision by a clerk of the works, and with that you would have no difficulty in getting good work. Therefore I prefer that building should be by contract.

The vote of thanks having been unanimously accorded,

Mr. Campbell, in reply, said: Mr. Hayward will note that I expressly exempted Battersea with Woolwich from the general custom of acceptance of engineers' own estimates as the basis of cost, and to this exemption I am bound to say I adhere as sound in idea. If engineers are to become their own contractors, having as one of their primary objects the presumed saving of money, councils, and certainly the ratepayers behind the councils, are entitled to some proof (1) that the estimate is a reasonable one, and is not inflated, and (2) that the final result in the return of cost kept by an altogether independent skilled accountant in the person of the borough treasurer shows either a profit or not. When I state, "the saving of money has not been realised to any encouraging extent," I mean of course over and above the allowance for establishment, plant, and depot charges. These work out at about 10 per cent. in the Author's case. If the individual workman would only realise that upon his personal effort depended the success of the labour policy, there would not be much fear of final results. If there is any detail of works organisation where a contractor excels, it is in the almost profligate system of supervision by foremen and sub-foremen that he applies, as compared with the oft-times niggardly methods in this detail of councils works departments. Moreover, a contractor may and does reward individual diligence, but corporations are hide-bound by a literal observance of a set of rules and regulations which discourage their workmen. The

whole question is so much one of public policy, that it behoves the corporations of those great towns to decide this question one way or other; and if decided for direct labour, so to back their officer in his otherwise unrewarded efforts as to make failure impossible, and to crown the policy with that good success of which—under like conditions to those meted out to it by and under the London County Council—it is capable.

Communicated Discussion.

Mr. Wike writes: In this paper three reasons are quoted in favour of a direct labour policy. In Sheffield for the last eight years the expenditure on works carried out by direct labour under the city surveyor's department (which should be distinguished from the late works construction dapartment) has averaged about 300,000*l.* As many as 2534 men have been employed—the present number is 1513—and in my opinion not only have the Council secured satisfactory work, but they have got it at a minimum cost. In large towns, it should be possible, if the management is satisfactory, to carry out street and sewer work, tramways, and similar undertakings, at less cost than a contractor. The reasons are simple. A corporation can buy its materials in large and regular quantities, and can arrange for twelve months in advance, which a contractor cannot do, as he must see an outlet for his materials before he can buy. In most cases he must pay standard wages, just as a corporation would; he has the same incidental charges, which Mr. Campbell puts at 10 per cent.—a figure I agree with—and over and above all this, he has his profit to make, which a corporation has not. If the cost is to be kept within reasonable limits, the estimates must of course be based upon analysed figures, and the actual cost must be checked. Personally, I do not see the necessity for further check by the employment of outside experts to test the engineer's estimates. If the engineer is not competent and trustworthy it is a mistake to retain his services. On the other hand, I do not think it fair to ask for a free hand in the purchase of material. With few exceptions it is practicable to bring up requirements and get them sanctioned by the committee in advance. The foregoing remarks do not all apply to building contracts. "Every man to his trade" is generally a sound doctrine, and building is a trade to itself. Recently a separate works construction department

under a separate committee and management was started to deal with our new buildings and property repairs. The quantity of work was irregular—building work is far less constant than roadmaking and sewerage—there were other difficulties, and eventually, the department having been wound up at a loss, the contract system was reverted to except for repairs and small additions. I notice sewers and sewage disposal works, unless of small magnitude, are not considered suitable for direct labour, on account of the risk. Is it not, however, the fact that a contractor covers these risks in every case, and the Council has to pay for them, whether any extra expense is incurred or not? If they carry out the work themselves, they only pay for such contingencies when they are actually experienced. Timekeepers and storekeepers should in my opinion be under control of the officer organising the department. Properly arranged, one sub-official checks another, and again I say, if the responsible official is not above suspicion in the matter of accounts, he ought not to have the supervision of important public works. The attitude of the Local Government Board with regard to payments out of borrowed moneys to salaried officials is well understood, and probably the Association has already made up its mind on that point, but the case of the workmen is new. The requirement that no wages of permanent staff or workmen shall be charged against loans is a difficult one to meet, and the point is one upon which I think the Association might well approach the Board.

MOTOR VEHICLES FOR MUNICIPAL WORK.

By JOHN A. BRODIE, M. Inst. C. E.,
M. I. Mech. E., Wh. Sc.; City Engineer, Liverpool.

Early History.

The use of light motor vehicles for industrial and other purposes first became practically possible in this country after the passing of the Motor Car Act of 1896, and about this time several societies and associations were formed for the purpose of gathering together persons interested in the advancement and improvement of motor traction on ordinary roads.

In 1896 a branch of the Self-Propelled Traffic Association was formed in Liverpool, having on its Council a number of influential representatives of the shipping interests and trade of the Port of Liverpool, and of the engineering profession, who expended a large sum and gave much valuable time for the purpose of encouraging the construction of motor vehicles for commercial purposes; and exhaustive trials held in 1898 and following years in Liverpool, together with the very full reports and particulars of the performances of the vehicles, probably did more than anything else in the early days of the movement to make known the possibility of the heavy motor vehicle.

It was soon seen that a considerable opening for such vehicles would be found in the work carried out by Municipal authorities, and during the trials in May 1898, the then Lord Mayor of Liverpool (the late Alderman Houlding), publicly stated that he was so much impressed with the working of the motor wagons that he would do what he could to see whether the motor car would not be a great improvement in the Corporation service, as compared with horse-and-cart traction.

At the conclusion of the first motor trials an order was

placed with the winners of the Gold medal for a 4-ton steam vehicle, for the use of the Liverpool Corporation; and this machine which was delivered in January 1899 is still at work, though it was soon found advisable to reduce the load carried and to use the vehicle for a lighter class of work than was originally intended. It has, however, been found a most valuable help in quickly conveying materials from depots to street works in progress and for street gravelling, and during the summer season it has been also largely used for street watering and other purposes in which the weight of the load to be carried is not a matter of first importance.

The experience gained by the regular working of the earlier types of vehicle was of considerable value to users and manufacturers, and it was soon found that oil firing would have to give place to coal or coke-fired boilers, whilst, contrary to the general practice in the lighter type of vehicle, the vertical type of engine originally adopted has also given way to the horizontal type, no doubt principally due to the demand for platform space.

After the completion of the third Liverpool trials in 1900, the City of Liverpool ordered from the Lancashire Steam Motor Company, Leyland—who again secured a gold medal—six 4-ton steam motor wagons, which were obtained in the beginning of 1901, and these wagons have been continually in use up to the present time.

At first, owing to the training of drivers and the elimination of unsatisfactory men, the proportion of time lost from actual work was excessive, but this was reduced as the men gained experience.

Liverpool Corporation's Vehicles.

These wagons have been well maintained and are now in good working order, all unsuitable portions having been replaced; and the repairs at the present time are costing less than formerly, whilst the average time lost is also less than at any period of their life.

The principal troubles which have been experienced in connection with the use of these motor vehicles have arisen from the fact that they were originally constructed to comply with the then existing law that the tare weight should not exceed

3 tons, which it was thought advisable to make one of the conditions of the specification.

It was, however, soon found impracticable to adhere to the tare limit, if the vehicles were to carry paying loads, and very considerable alterations have had to be made to them; and the weights of such parts as frames, springs, axles, and wheels have been materially added to—the total weight with steam up and ready for work now amounting to 4 ton 19 cwt. on the average, as against their original nominal tare of 2 tons 19 cwt. 3 qr.

The passing of the Motor Car Act of 1903, combined with the regulations which were subsequently issued, was welcomed by motor wagon users throughout the country generally, as it legalised the additions which had already been made as a matter of necessity. The alteration in the weight limit, together with the additional requirements as to the width of tyre, appear to have met the demands of motor users; and since the necessary alterations to comply with the provisions of the Act have been completed, the difficulty at first experienced in maintaining the motor wagon wheels, has entirely disappeared, and the only difficulty which still remains is the noise and vibration caused by the running of the wheels over the comparatively rough roadways; and this difficulty is likely to remain so long as a rigid wheel is driven at a considerable speed over the rigid and uneven roadways which still exist to a considerable extent in the older neighbourhoods of Liverpool.

Wheels.

In Liverpool, a considerable number of wheels have been experimented with. In the first instance the manufacturers of a solid rubber tyre came forward and offered a contract with the payment arranged on the basis of mileage run, the existing wheels being provided by the company with special rims suitable for their own type of solid rubber tyres. The front wheels of the wagon, which at that time carried an axle load of 2½ tons, ran some 1500 miles before failing and satisfactorily reduced noise and vibration so long as they lasted. The driving wheels which carried an axle load of 6½ tons, only lasted 300 miles; and up to the present time, though every effort has been made to obtain a guarantee of solid rubber tyres, no manufacturer has

been found ready to contract with the Corporation for rubber tyres for these vehicles, although for some purposes the Corporation were prepared to pay a rate per mile in excess of that now annually paid for the maintenance of motor omnibus tyres.

A trial was also given to an early type of resilient wheel manufactured under the Gare patents, the tyre consisting of hardwood blocks, jointed on rubber with treads consisting partly of fibrous material, the whole being completely impregnated with rubber solution. So far these wheels have not completed their mileage under the contract. This type of wheel has, undoubtedly, advantages, especially in the matter of freedom from side-slip on stone set pavement and also to a great extent from noise, but there appears to be some difficulty in making it sufficiently lasting in the case of the driving wheels where the axle load amounts to 8 tons.

A metallic wheel under the Hele-Shaw patents has also been experimented with, and this type of wheel has completed a distance of about 3000 miles. In this wheel the spokes are made of steel and provision made for play at the hub something after the style of a toggle joint. The noise and vibration have been considerably reduced, but up to the present time the spokes have been rather light for the strains thrown upon them in Liverpool due to the axle weight and the rough condition of the boulder-paved streets passed over.

An offer was also accepted for the trial of a pair of wheels with a rubber tyre shielded by metallic sectional plates, called the "Buckingham" tyre, but this wheel did not give satisfactory results, as a number of the shields gave way, and these had the effect of injuring the resilient tyre underneath.

Another pair of wheels has been tried to some extent, the tread portion consisting of paper impregnated with a composition and afterwards compressed between plates, and this arrangement has undoubtedly resulted in a quiet wheel, but the trial has not been sufficiently extended to state definitely whether a satisfactory life can be got out of it.

Some two years ago the idea occurred to the Author that it might be worth while to try the wear of double pneumatic tyres with an outside stiffened rim, so that the vibration due to the hammering of the tyre on the setts need not be transferred to the machinery, and a pair of wheels on this principle were constructed and have been continuously in use since January 1905,

travelling over 5000 miles, and have required practically no attention beyond the fixing of stops between the outer and inner rims so that slip and consequent wear between the stiffened rim and the rubber tyres could be avoided.

A peculiarity which has been observed is that the wear on the steel tyre is noticeably less than in the case of the tyres shrunk on to wooden wheels direct, and the cost of maintaining the machinery is also less, due apparently to the reduction of vibration.

Several types of rigid wooden and metallic wheels are now in use which have not cost anything for repairs since they were altered to comply with the new requirements as to width, and no cases of injury to road surfaces by motor wagon wheels have since been recorded in Liverpool.

Axles, Axle Arms, Springs, Etc.

The Liverpool vehicles were originally fitted with cast-steel cranked axles and axle-arms. This material, however, does not appear to be suitable for the severe shocks and strains thrown upon it in practice, and it has been found necessary to replace these axles by straight axles of wrought steel of good quality, with the spring seatings shrunk on, and the axle arms, in the case of the front wheels, being also made of forged steel. These axles have now been in use for a period of approximately two years without failure. The steel springs originally supplied with the vehicles gave trouble from time to time, and it became necessary to strengthen them by fitting additional leaves, and in the case of new springs it has also been thought advisable to reduce the camber. Considerable advantage has also been found from the fixing of grease-cups on the shackle ends and moving parts of springs, and this also applies to all moving portions, as provision for continuous lubrication of all moving parts of motor vehicles is useful in preventing loss of time when on the road.

Brakes.

Though the drivers of steam vehicles use the engine to a great extent for the purpose of braking, both the brakes required to be provided by law should be kept in good condition, and experience shows that the best results are obtained from brakes

on which the surfaces are metal to metal, the brake straps lined with wood originally supplied with the vehicles having been discarded.

Engines and Gears.

The engines and gears have continued to give good service without requiring very much in the way of repairs.

Boilers.

The boilers of the whole of the vehicles in use by the Corporation of Liverpool are of the vertical fire-tube type, which have given an average life of four years before requiring important repairs, except in the case of two furnace crowns which were damaged through shortness of water. The whole of the tubes have been removed and renewed during the past twelve months at a cost of about 13*l.* per boiler, and the boilers are now quite equal to new throughout.

It is very important that all workmanship and materials in connection with boilers for motor work should be first class, and that the design should be as free as possible from small parts and corners which cannot be cleansed and washed out, which work should be done at short intervals and as thoroughly as possible. This work, as well as everything in the nature of repairs to such vehicles, should be under the control of men practically acquainted with engine and boiler work, and even where such men are available it is well to have an independent inspection of the boiler during construction and subsequent annual inspection and guarantee by one of the first class associations who undertake this kind of work.

Spares.

Where, as in the case of Liverpool, a sufficient number of vehicles are employed, it has been found a considerable advantage to keep repaired and ready for use interchangeable spare parts such as:

1. A boiler complete.
2. A back axle with wheels and springs complete.
3. A front axle with wheels and springs complete, as well as chains and other parts which require renewal from time to time in the ordinary course, and much loss of running time may

be avoided by the quick removal of injured parts for repairs and their replacement by the parts kept ready for immediate use.

Methods of Working Double Shifts.

The vehicles were at first put on ordinary day work, but as they did not compare so favourably with horse haulage as was expected, they were for a period of about eighteen months put upon double shifts, and this had the effect of reducing the cost to a point below horse haulage.

As the vehicles in question were principally used for collecting refuse and conveying it to the destructor stations, the working of double shifts was found a great convenience, the material coming in at approximately a constant rate throughout the working hours of the destructors which were already on double shifts, viz. from 5 o'clock a.m. to 12 o'clock (midnight), or a total of 19 hours per day. This method of working was found specially suitable for the distribution of refuse to the destructors which were used for steam raising purposes.

The most serious hindrance to this method of working arose from the complaints received from persons who were disturbed either in the early morning or late at night by the noise and vibration of the vehicles passing their houses, and the objections on this ground became so numerous and continuous that it was ultimately decided to restrict the use of the vehicles to the hours between 7 o'clock a.m. and 7 o'clock p.m., and to reduce their speed when loaded.

Trailers.

It was again found that the vehicles were not comparing favourably with horse haulage, and with the object of obtaining better results trailers were adopted.

Owing to the number of large horse team wagons available these were utilised as trailers for the motors. Some little difficulty was experienced in getting these vehicles to properly track with the motors, owing to the fact that most of the weight came upon the rear axle, and only a small proportion on the front or steering axle. By arranging the draw-bar, however, so that the pull from the motor came upon the body of the trailer, and making use of the bar from the front wheels for steering pur-

poses only, the difficulty was satisfactorily overcome, and the vehicles as now arranged give every satisfaction.

A local difficulty which arose may here be mentioned. It was found that young boys were much attracted by these vehicles, and that they would persist in attempting to ride on the short length of draw-bar connecting the motor with the trailer, and notwithstanding repeated warnings several serious accidents occurred. This practice of the boys increased to such an extent that it became necessary to provide an extra man for the purpose of keeping them clear until the front of the trailer could be fitted with a semicircular sheet iron casing so that no hold remained for the boys, and the practice has now entirely disappeared.

Annual Cost of Working Liverpool Corporation Motors.

A fair statement of the annual working costs of these vehicles based on the present year's expenditure would be as follows:—

Liverpool Corporation Motor Wagons.

Statement of Annual Working Costs, based on Present Year's Expenditure and a Life of Ten Years.

	Cost per Wagon per Annum. £	s.	d.
Repairs, including proportion of renewals	136	17	4*
Working expenses—			
Wages of driver and assistant, including proportion of night men at depots	125	11	11
Fuel oil and stores	56	1	8
Sundries, including insurance, establishment charges, and contingencies	24	15	0
Interest, 3½ per cent. and sinking fund, based on life of ten years	63	2	6
	£406	8	5

* In the case of a new and up-to-date vehicle, the item for repairs and proportion of renewals might be fairly taken at 100*l*., the other charges remaining the same.

Average number of working days per motor vehicle per annum 245, and average charge per day 1*l*. 13*s*. per motor vehicle.

Average inclusive charge for horse vehicle in Liverpool, including driver, 9*s*. 4*d*. per day.

of Work. Distance travelled, 2¼ miles each way.

—		Motor Wagons. Times kept.	Motor Wagons. Time occupied.	Horse-drawn Vehicles. Times kept.	Horse-drawn Vehicles. Time occupied.	Weight of Load Carried. Motor. tons.	Trailer. tons	Trailer. cwt.	Horse vehicle. tons	Horse vehicle. cwt.	Horse vehicle. qr.
1st load	Left P.... Depot (or stable)	7.0 a.m.	Journey . . 27 min.	6.0 a.m.	Journey . . 50 min.						
	Arrived T.... Road, 2¼ miles	7.27 „		6.50 „							
	Left T.... Road	8.47 „	Loading . . 80 „	8.10 „	Loading . . 80 „	5	3	0	1	10	0
	Arrived C.... Street Depot	9.17 „	Journey . . 30 „	9.8 „	Journey . . 58 „						
	Left C.... Street Depot	9.35 „	Tipping . . 18 „	9.23 „	Tipping . . 15 „						
2nd load	Horse baiting	..	.. ..	10.3 „	.. 40 „						
	Arrived T.... Road	10.2 „	Journey . . 27 „	10.53 „	Journey . . 50 „						
	Left T... Road	11.22 „	Loading . . 80 „	12.13 p.m.	Loading . . 80 „	5	2	14	2	2	2
	Arrived C.... Street Depot	11 52 „	Journey . . 30 „	1.11 „	Journey . . 58 „						
	Left C.... Street Depot	12.10 p.m.	Tipping . . 18 „	1.26 „	Tipping . . 15 „						
3rd load	Horse baiting	..	.. ..	2.26 „	.. 60 „						
	Arrived T.... Road	12.37 „	Journey . . 27 „	3.16 „	Journey . . 50 „						
	Left T.... Road	1.57 „	Loading . . 80 „	4.36 „	Loading . . 80 „	5	2	9	1	9	2
	Arrived C.... Street Depot	2.27 „	Journey . . 30 „	5.34 „	Journey . . 58 „						
	Left C.... Street Depot	2.45 „	Tipping . . 18 „	5.49 „	Tipping . . 15 „						
	Arrived at Depot	..	.. ..	5.59 „	Journey . . 10 „						
4th load	Arrived T.... Road	3.12 „	Journey . . 27 „	..	.. ..						
	Left T.... Road	4.32 „	Loading . . 80 „	..	.. ..						
	Arrived C.... Street Depot	5.2 „	Journey . . 30 „	..	.. ..	4	2	3			
	Left C.... Street Depot	5.20 „	Tipping . . 18 „	..	.. ..						
	Arrived at P.... Depot	5·30 „	Journey . . 10 „	..	.. ..						
					Total weights . . .	19	10	6	5	2	0

Average Times.

—	Loading.	Journey Loaded.	Tipping.	Journey Empty.
Motors	80 min.	30 min.	18 min.	27 min.
Horses	80 „	58 „	15 „	50 „

Average Weight of Loads.

	tons	cwt.	qr.
Motor	4	15	0
Trailer	2	11	2
Horse vehicle . . .	1	14	0

Summary.

	Motor and Trailer.	Horse Wagon.
Cost per day	1l. 13s. (= 1s. 1½d. per ton) . .	9s 4d. (= 1s. 9·9d. per ton)

Comparison between Operations of Horse-drawn Vehicles and Motor Wagons.

With the object of enabling a fair comparison to be made between the operations of horse-drawn vehicles and motor wagons on exactly similar classes of work in Liverpool, the following tables have been drawn up showing the actual times occupied when working between the same loading districts and depots over distances of about 2¼ miles.

Compared with horse haulage it will be seen that the perfecting of the arrangements for speedy loading and discharging is of very much greater importance in the case of motors than of horse vehicles.

With heavy horses such as are in use in Liverpool, the average mileage travelled does not exceed fifteen miles per day, and as this distance can be travelled in from five to six hours there is left an ample margin of time for the operations of loading and unloading.

With motor wagons, however, the mileage travelled is limited only by the legal limit of speed and the time available for running, and it therefore becomes very important that the time of loading and unloading should be reduced as much as possible, so that the time for travelling may be correspondingly extended.

By improvements in organisation it has been found possible to arrange for the loading of the motor wagons and trailers—a total load amounting to about eight tons—in the same time as is required for loading the horse wagons, averaging about one and three-quarter ton, whilst it has also been found possible to unload the motor and trailer in approximately the same time as the horse vehicle, and consequently a considerably greater tonnage is brought in than was originally the case in Liverpool.

The following statement gives a fair comparison of costs over all the various distances which are usually collected to one depot in Liverpool :—

COMPARATIVE STATEMENT OF COSTS BETWEEN MOTOR WAGONS AND HORSE DRAWN VEHICLES OVER VARIOUS DISTANCES.

3-Horse Load Districts—2½ miles.

				s.	d.	
4 motor wagon loads, with trailer ..	29⅓ tons	..	Cost	1	1½	per ton
3 horse loads..	5¼ ,,	..	,,	1	9¾	,,

4-Horse Load Districts—1¾ mile.

4½ motor wagon loads, with trailer ..	33 tons	..	Cost	1	0	per ton
4 horse loads	6¾ ,,	..	,,	1	4½	,,

5-Horse Load Districts—1½ mile.

6 motor wagon loads, with trailer ..	44 tons	..	Cost	0	9	per ton
5 horse loads..	8½ ,,	..	,,	1	1	,,

6-Horse Load Districts—1¼ mile.

6 motor wagon loads, with trailer ..	44 tons	..	Cost	0	9	per ton
6 horse loads..	10⅓ ,,	..	,,	0	11¼	,,

7-Horse Load Districts—1 mile.

6 motor wagon loads, with trailer ..	44 tons	..	Cost	0	9	per ton
7 horse loads..	12 ,,	..	,,	0	9¼	,,

8-Horse Load Districts—⅞ mile.

6 motor wagon loads, with trailer ..	44 tons	..	Cost	0	9	per ton
8 horse loads..	13 ,,	..	,,	0	8½	,,

9-Horse Load Districts—¾ mile.

6 motor wagon loads, with trailer ..	44 tons	..	Cost	0	9	per ton
9 horse loads..	15¼ ,,	..	,,	0	7½	,,

NOTES.—1. The motor wagons are employed on the 3-horse load districts so long as there is sufficient work to keep them going, and otherwise as long distance journeys as possible.

2. In ordinary work, horses are used entirely for the shortest distance journeys.

3. On 6, 7, 8, and 9-horse load districts, the carts are left for filling during the time the horse is running to the destructor depot and back.

STREET WATERING.

When occupied on street watering the following gives the time occupied in the various processes in Liverpool for motors and for horses working under exactly similar conditions :—

WATERING.

	Motor. min.	Horse. min.
Time occupied from depot to hydrant	10	30
" " hydrant to depot	10	30
Fixing and taking off tackle for loading ..	1½	3
Time occupied for loading..	3	3
" " distributing	4	6
" " travelling..	4	6
" getting to hydrant empty	½	1½

In the case of the City of Liverpool, on dry days a minimum of forty horses are usually employed upon street watering, the average useful mileage per day obtained from these horses amounting to about 8 miles. On the driest and hottest day a maximum of about seventy-five horses are employed, which at the same average mileage gives a total of 600 miles of useful watering.

The motor wagon at present in use in Liverpool for street watering sprinkles the whole width of a 32 ft. road in one operation, as compared with a width of 16 ft. by the horse vehicle. This increased spread has been attained by lifting the tank, but it may also be obtained in the case of motor vehicles by the lift-pump arrangements, recently introduced by Messrs. Glover, of Warwick, in which the head is kept constantly at a level greater than the natural fall due to the level of the water in the tank.

By the improved width of spread possible the mileage can be practically halved as compared with water distribution from a horse vehicle. The motor watering wagon in Liverpool is kept at work on an average for a period of twenty hours per day, and assuming that an average speed of 6 miles per hour can be obtained—which is practically what is accomplished in actual practice—the length of street dealt with by motor wagon amounts to 35 miles for two shifts with 32 feet of spread equal to 657,000 square yards, and on this basis it displaces approximately eight horses.

Assuming that the total charge for the motor wagon per shift amounts to 1*l*. 13*s*., the total cost of watering a mile of road averaging 32 feet in width would amount to 1*s*. 10·52*d*. with motor per day, and 2*s*. 3·78*d*. with horse per day.

In the case of motor watering, in addition to speed, the

following additional advantages may be claimed for the motor, viz.:—

1. That as the load is so much greater a proportion of the time lost in connecting and disconnecting to hydrant is saved.

2. That a proportion of the time lost in running to hydrants is also saved; and

3. That owing to the weight and stability of the vehicle, the load may be carried at such a height as to treat roads of ordinary width in one operation.

SWEEPING.

With regard to the question of street sweeping by means of a revolving brush attached to a motor vehicle, it appears somewhat questionable whether any great advantage from an economical point of view is obtainable under ordinary conditions, as the speed of the motor must be kept low, and consequently the work done does not exceed twice that done by the horse vehicle: whereas the proper charges for the motor wagons must exceed the cost for two horse vehicles.

In connection with street sweeping there appears to be an opening for a combined motor sprinkling and sweeping machine, but it should be capable of sweeping a track at one operation considerably wider than the ordinary horse brush, and if possible it should also be capable of lifting the materials collected by the brush and depositing them in the body of the wagon.

Several arrangements designed with this object have come under the notice of the Author, but so far he has not seen one which he considers suitable for dealing with the materials swept from streets under all the varying conditions of weather.

USE OF MOTOR VEHICLES GENERALLY.

The work which comes under the control of the surveyor is so variable in character that attention should perhaps be called to two developments in motor traction which will no doubt be found useful where the conditions are found suitable, viz.:—

1. The medium weight petrol wagon on rubber tyred wheels, and

2. The light tractor.

In many districts strong objection is offered to the use of

heavy wagons with iron-tyred wheels, and in some cases no doubt authorities will consider that the advantages of freedom from vibration and noise together with the greater speed, viz. 12 miles per hour, allowed to such vehicles will more than counterbalance the advantages of economy possessed by the heavy motor wagon, and it appears likely that there will in the near future be a considerable development in this direction.

The light tractor is also at the present time considerably in evidence, and where the conditions of loading and unloading are such that the wagons cannot be quickly loaded, or where there may be considerable delays before the material can be delivered on the site of the works, they will no doubt be used.

It appears likely, however, that the motor wagon and trailer will be more economical in working for urban purposes generally.

Ambulances, Etc.

The work done by ambulances, viz., the removal of sick and injured people to the hospitals, as also the removal of infected clothing to the disinfectors, and its return after disinfection, appears to be specially suitable for more than one class of work, and there are now several methods by which the one body can be quickly removed and another placed in position without delay.

Steam vehicles have been recommended for this class of work largely on account of their quietness and smoothness in operation. Where, however, used for emergency purposes many 4-cylinder petrol engines are now almost equally silent and free from vibration, whilst they have the additional advantage of always being ready for work at a moment's notice if kept in good condition.

Motor Fire Appliances.

Another branch of work in which the motor must, in the near future, displace horses is in the service of the fire brigade, and in this line already a fire-brigade can hardly be considered up-to-date which does not contain samples of motor-propelled vehicles.

In no branch of the municipal service is promptness in starting and speed on the road of greater importance than in

connection with an outbreak of fire. In many cases fires which would otherwise have developed into large conflagrations have been saved by the early arrival of the reel wagon.

In Liverpool there are, at the present time, under the charge of the head constable, three automobile fire-engines and one motor tender, and the following extract from his annual report puts very concisely his opinion of the merits of the motor vehicle for such purposes:—

"The economy of these in place of horse-drawn machines is manifold; those which are equipped with chemical cylinders, as two of the present and all the new ones will be, supply the place of both a first-turn machine and a steamer, while the substitution of oil fuel for coal practically does away with the want of a tender, the tanks carrying enough oil for a fire of anything but exceptional duration. The one machine may therefore be said to take the place of three machines and three pairs of horses, while the gas for keeping up steam costs no more than the bare forage for one pair of horses. The driver on arrival at the fire has no horses to look after, and is available as a fireman."

Economy in Accommodation.

In comparing motor vehicles with horse traction a point which should not be overlooked is the relative cost of housing accommodation.

In stables, in addition to the space required for the horses, and also the covered accommodation for carts, a large proportion of building is required for storage of fodder and for the preparation of the food, harness, etc.—the total space required for motors only amounting to about 50 per cent. of that required for horses, whilst the class of building may also be of much less expensive character.

Light Vehicles.

The Liverpool Corporation have in use at the present time eleven vehicles of the heavy type, and they have also ten light vehicles which are used by officials and members of committees in connection with the works of the municipality.

The experience gained with these latter vehicles may be of some assistance to Members of the Association who may be considering the use of such vehicles in connection with their

duties, or who may have work for which the light petrol vehicle is suitable.

Having had a training as a mechanical engineer, the Author at first perhaps naturally favoured the vehicle propelled by steam. His experience with some of the early types of steam vehicle, however, forced him to the conclusion that the advantages of the steam engine, viz. its elasticity and smoothness, were more than counterbalanced by the difficulty in obtaining a satisfactory supply of water and of maintaining the very light type of vertical fire tube boiler then in use, and that these disadvantages would at any rate for the time be sufficient to severely handicap any light steam vehicle intended for use over considerable distances.

Attention was, therefore, directed to the petrol explosive engine, and in 1901 the Author acquired one of the earliest motor bicycles, covering, during the summer, some 7000 miles. Where cheapness in first cost and subsequent maintenance is a matter of necessity, whilst at the same time considerable distances have to be covered, the motor cycle may with advantage take the place of the ordinary cycle for the younger and more active Members.

For many purposes of the surveyor, however, the three-wheeled vehicle is superior, and especially is this the case during the winter months and wet weather, when greasy roads may have to be negotiated at nights. A very suitable form is the motor bicycle, which in bad weather can be readily converted into a tricycle or fore car. The cost of running such a vehicle (which does not require a driver) should, on an average of 6000 miles per annum, work out approximately as follows:—

Total cost, £60.

	d.
Life, say three years, £20	·8
Tyres	·2
Petrol and stores	·2
Repairs	·2
Licences, etc.	·1
Total cost	1·5d.

Cost per mile taken on 6000 = 1·5*d*. per mile.

The two-seated car comes next in the order of size, and will be found to very satisfactorily meet most of the requirements of a surveyor.

Where greater seating accommodation is occasionally required,

this is best supplied by having the back or tonneau portion removable, or by separate hiring of a larger vehicle according to the requirements of the case, and it should not be forgotten that working costs (and particularly the cost of tyres) are considerably increased by the carrying about of any unnecessary weight.

With regard to the number of cylinders recommended for such a car, the Author considers that a single or two-cylinder car of 8 to 10 horse-power meets all requirements for a two or occasional four-seated car, but if a four-cylinder car is preferred it can now be obtained from several makers at a reasonable cost. It appears, however, doubtful whether for purposes of hard work the additional smoothness in running is not more than counterbalanced by the additional complication, especially where a trained driver is not kept.

The cost of running such a car taken on a basis of 8000 miles per annum should work out on the average as follows:—

First cost, including spares, hood, and screen, £200.

	d.
Life, say four years, £66	1·50
Tyres	1·20
Petrol, stores, and ignition	·64
Repairs	·64
Insurances and licences	·27
Driver, if required	1·87
Total cost	6·12*d.*

Cost per mile taken on 8000 miles = 6⅛*d.* per mile.

When a larger car is required it is seldom necessary to exceed 16 to 18 horse-power. Such a car requires the attention of an experienced driver, and, when provided with seats for five exclusive of the driver, is found useful by sub-committees for inspection purposes.

The cost of running such a car should on the average work out as follows:—

	d.
Proportion of life, say five years	3·0
Tyres	1·5
Petrol oil and stores	·8
Repairs	·8
Insurance and licences	·3
Driver	2·0
Total cost	8·4*d.*

Cost per mile taken on 8000 miles per annum = 8½*d.* per mile.

In connection with the purchase of the above types for the purposes of the surveyor or engineer, the following points should be insisted upon :—

Tyres, especially on driving wheels, should be larger than sizes recommended in tyre-maker's list, and should also have an ample thickness of rubber outside the canvas.

All gears should be lower than for touring cars, and especially should this be so in the case of the lowest gear, as surveyors are often off the main roads and in many cases require the car to mount steep hills, which the makers do not usually provide for.

Brakes should all be metal-to-metal and easily adjustable. The clutch should not be withdrawn by the action of putting on either of the brakes, as the engine can in this case be used as an additional brake on steep hills.

Where a single ignition is fitted, the accumulator and coil, though not free from trouble, are on the whole better than most magnetic ignitions alone.

The control of the engine should be by governor and pedal accelerator, and the hands should be left free for steering.

There is great scope for the further utilisation of such vehicles in connection with a surveyor's everyday work. They are of great advantage in enabling the surveyor to keep in close touch with the progress of the works, so that he may see for himself from time to time that the men under his charge are conducting them to the best advantage. They also enable him to make personal inspections promptly when required, and to keep a check upon expenditures in a way which it would otherwise be impossible for him to do.

The Author is, therefore, in favour of motors wherever such vehicles can show an advantage over present methods, whether the improvement be in the direction of greater economy or of the more prompt dealing with such matters as affect the public health, and he considers that the successful road surveyor of the future will require to have an intimate knowledge not only of the action of such vehicles on the road surfaces, but also the effect of the road surfaces on the vehicles and their occupants.

He therefore advises the younger Members of this Association to acquire a practical knowledge of the motor by personally driving and maintaining where possible, as in this way the best knowledge is obtained, and without this knowledge it is very

difficult to thoroughly understand the modifications which the fast motor requires in connection with road surfaces.

Some points which have occurred to the Author as objectionable in passing over road surfaces when motoring are as follows :—

1. The abrupt endings of patches which are hardly noticeable with slow traffic and large wheels, but cause an unpleasant jolt if passed over quickly in a motor vehicle.

2. The excessive rounding of the sides of roads practised in some counties, which tends to make the roads dangerous for fast traffic, especially in wet weather.

3. The crossfall to outside of quick curves, which drives fast traffic to keep the inside of the bend to obtain the super-elevation of the outer wheel, which means safety as compared with the danger of side-slip if taken on the outside.

4. The elevation of paved crossings and manholes above the surface of macadam roads, especially in towns and populous places.

5. The too sudden rise in the surface of the roadway over small bridges and culverts, which causes severe shocks and sometimes jumping of long wheel base cars.

6. The non-removal of loose stones. These in some districts are raked to the side once or twice daily, a great advantage to all users of rubber tyred wheels.

As one who enjoys motoring on good roads, and who has from time to time inflicted a considerable amount of dust upon the other users of the road, the Author thinks it a great pity that no serious attempt has been made to tackle the dust nuisance from a point of view which automobilists might well be expected to take up.

Each time a fast car passes along a dusty road it puts a considerable percentage of the dust in motion, most of which settles down on the surface of the road, to be again disturbed by succeeding cars.

If some of our automobile friends would tackle the dust nuisance by means of a fast vehicle in such a way as to enable authorities responsible for lengths of main roads to satisfactorily remove all dust from such roads daily, they would be doing something to encourage the further extension of the automobile industry, and they would have little difficulty in finding a

market for such an apparatus—as it appears likely that for some time to come many roads will continue to be made of the most economical materials available.

Whilst, therefore, it is clearly the duty of the surveyor responsible for roads to experiment with dustless materials, and to find, if possible, methods to prevent the dust from being formed, or (when formed) from rising, it is equally the duty of the motorist to do all that can be done by mechanical means to provide for the removal of the dust, if this be attainable, or to so design his vehicle that its passage over a dusty road need not cause greater inconvenience than other vehicles to the general public, who are entitled to fair treatment on the public highways of the country.

DISCUSSION.

Mr. H. T. Wakelam: I wish to propose a hearty vote of thanks to Mr. Brodie for his paper. About a month ago I got out some figures showing the depreciation of various types of motor cars, and the car we decided upon getting comes, for 15,000 miles per annum run, within ·21 of the amount allowed for depreciation for the four-cylinder light car. Mr. Brodie has also given us some very interesting points as to the construction of cars. I quite agree with the points put forward by Mr. Brodie, with the exception of No. 5. "The too sudden rise in the surface of the roadway over small bridges and culverts, which causes severe shocks, and sometimes jumping of long wheel base cars." That is a matter which requires very careful consideration, because it is not competent to alter much the old bridges we have to deal with, to say nothing of the bridges of railway and canal companies. If there is one class of bridge on main roads that is a cause of difficulty and trouble it is the old hog-backed bridges, and the sooner they are all removed the better.

Mr. A. E. Collins: I have pleasure in seconding the vote. I have noticed a tremendous difference in the cost of the upkeep of steam wagons now as compared with the cost a few years since. The first motor wagon I had was built about three years ago, and from the first day it was put in use began to cost money for repairs, and when we had used it twelve months, I

thought we should have to give it up, it was costing so much. During this twelve months we got rid of most of the weak parts, and the cost of repairs fell considerably. Three months ago we bought another wagon, built under the new regulation as to weight, and it has not cost a penny in repairs, which shows the great difference effected by the alteration in the law. With good steam wagons where you can manage to load and discharge quickly, you can do the work much cheaper than with horses.

Mr. W. HARPUR: My experience of motor wagons does not work out very favourably as to cost. I have four motor wagons in Cardiff for the collection of refuse, and giving them a ten years' life, and putting only one-half of the amount Mr. Brodie does for depreciation, that is to say 50*l.* instead of 100*l.*, I find that for short runs up to a mile and a half the cost of working motors for refuse collection runs to 35 per cent. in excess of that of horse power. The conditions no doubt in Cardiff, and the method of collection, vary very much from what they do in Liverpool, but even taking the Liverpool figures where a motor has to stand for eighty minutes for loading, I can hardly conceive it can work out economically if all charges are included. In Cardiff I put my average working day's expenses at 27*s.*, as against Mr. Brodie's 33*s.*, and the average cost of horse and man is 9*s.* 10*d.* as against Liverpool's 9*s.* 4*d.* I find taking that basis we are losing 4*l.* or 5*l.* a week on every motor we are working. As to motors for street watering, I have not the slightest doubt that when constantly working they will prove more economical than horse power. But there are other circumstances to be considered in connection with that. The water cart is not always wanted. What is to be done with motor water vans and their drivers on a wet day? Sewers do not always want flushing, and that is about the only other useful work to which you can put motor water vans when street watering is not necessary. I should not want them in Cardiff at any time for that purpose, because all the sewers are provided with automatic flushing tanks. It may be said that you can change the bodies so as to use the motors as ash-wagons. But you want your ash-wagons constantly in use for refuse collection, and even if you did not, changing the bodies daily takes time, and costs money. It seems to me that a more economical method where conditions are suitable, and where loads can be obtained at particular spots, would be by using motor tractors,

instead of motor wagons. That is to say, that the motor tractor could leave the empty wagons at particular points, and then when it had completed the round with the empty wagons, return and collect the loaded wagons. Such a system as that might, I believe, be worked economically. I am very glad Mr. Brodie has called the attention of manufacturers of motors as to what may be done by them in assisting us all round in our work.

Mr. O. E. WINTER: I have had two of Thornycroft's wagons for the last five years, and my experience has been somewhat similar to Mr. Brodie's: that the cost of their upkeep and repairs has been very heavy. The repairs to my wagons have averaged 150*l.* per annum, which is very heavy. I think that has been due largely to the working parts of the old type of motor van not being sufficiently strong to stand vibration. From correspondence I have had with some manufacturers recently, I find that some makers are prepared to undertake the upkeep of their wagons for a period of five years for payments varying from 30*l.* for the first year to 50*l.* for the fifth year. That shows they have considerable confidence in their machines. The cost of motor haulage stated in the comparative statement of cost given by Mr. Brodie strikes me as very low. I do not know whether all charges have been included in these figures, including all establishment charges. If that is the case these figures are very low, and I am afraid we could not carry out work in London at anything like that figure. My experience has been very similar to Mr. Harpur as to the cost of dust collecting; that motor haulage costs 30 to 40 per cent. more than horse haulage in this work. With regard to street watering, I have had excellent results. At Hampstead with the stiff gradients we have, the motor vans engaged in watering works out cheaper than horse haulage. The 1000 gallon tank does the work of five or six horses. They are also very valuable for washing paved streets and flushing sewers. The 1000 gallon tank fitted with a 10-inch valve provides a very effective flush. I keep the wagons usually on street watering and haulage of materials, and it is only on occasions when not required for this work that they are used for dust collection. My experience has been that if you have sufficient work to keep them running, especially on long journeys, motor haulage should prove economical.

Mr. E. G. MAWBEY: At Leciester we had such an experience

with a 1000 gallon motor flushing van as to convince us that it is efficient and economical. We now use it for washing out and flushing all the dead ends of the old sewers, where we have no flushing tanks. It is a very economical and effective arrangement of flushing such sewers. With regard to motor vehicles generally, I went into the matter thoroughly for scavenging purposes. We have destructors in several parts of the town to minimise the carting and we find it much cheaper to go on with the horse haulage. With regard to the state of the roads, I sympathise with the public with regard to the dust nuisance.

The vote of thanks having been unanimously passed,

Mr. J. A. Brodie, in reply, said: I thank you for the vote of thanks you have so kindly carried. With regard to the question of bridges raised by Mr. Wakelam, I was not grumbling so much about the gradients leading up to railway and other modern bridges with a fairly easy rise, as the bridges over small culverts which rise suddenly some few feet above the general surface of the road, where a rearrangement of the surface at a small cost would make travelling very much more comfortable for motor vehicles and other fast traffic. I have had experience of travelling over many of these small bridges, and the result was that in one case all four wheels left the ground. Mr. Collins referred to the cost of up-keep, and I should like to say that we in Liverpool have also gone through a troublous time owing to the legislation preventing the construction of motor wagons built on proper lines. The comparative tables of work were given in the paper for the purpose of letting persons interested see generally what the motor wagons have been doing under varying conditions as to length of cartage. In Liverpool, fortunately, or unfortunately, we have cartage distances of 2¼ miles, and on distances of 2¼ miles where you can get 20 to 25 miles per day out of the motor wagon, there is no doubt they are very economical. Where you get down to the short distances mentioned by Mr. Harpur, and you must have facilities for quickly filling your wagons—that is the essence of the whole thing, I have given a fair average time, eighty minutes for filling, but the work can be done in fifty minutes, and get another load out of the vehicle. For distances of a mile, the cost of 9*d.* per ton for the motor and 9½*d.* per ton for horse haulage, shows the border line. At this distance, if arrangements for loading and unloading are quick, the motor wagon can still pay, but if

the conditions are such that you cannot load quickly with the charge given, it cannot pay. With regard to Mr. Harpur's remark as to tractors, I am not quite clear where the tractor comes in and the motor wagon stops. If you have conditions where you cannot load and unload quickly, it may be that the motor tractor will be more advantageous than the motor wagon, generally speaking, in a town. I think the motor wagon will have the advantage. One of the reasons why in the case of a town I think you will get little advantage by having a tractor, is the difficulty of how the wagon is to be moved from place to place. Mr. Winter referred to the cost of maintenance. As I said before, we got our wagons at a time when wagons had to be built to a very light specification. We went through them piece by piece, and replaced the weak pieces by stronger parts. The Liverpool motor wagons were paid off in five years, and are now as good as ever. That is why I think, with reasonable use and renewals, the life of a motor wagon should be at least ten years.

ROAD CONSTRUCTION, MAINTENANCE, IMPROVEMENTS, AND SUBSIDIES.

By H. T. WAKELAM, M. Inst. C.E.,
County Engineer of Middlesex.

It is well known to most of the Members of the Association, that the suitability of the principles of road formation and construction, followed for so many years in this country, has of late been much questioned, as to whether the principles are framed on the right lines or otherwise, to meet the requirements of the mechanical traction introduced upon main and district roads in recent years.

In consequence of this mechanical traffic, and its resultant dust nuisance for five or six months of the year, considerable agitation has been, and is being, created in various directions, for an improvement of the highways of this country, and many ideas are being put forward with a view to effecting a drastic change and reform in the existing arrangements and systems, connected with road maintenance throughout England and Wales.

With these facts in mind, the Author proposes to deal very briefly with the subject-matter of this paper, so that all present may have an opportunity for discussing what, in his opinion, is of the greatest importance to the whole of the Members of the Association.

The principles of formation and construction referred to, have been based chiefly upon lines laid down by Telford and Macadam early in the last century, which lines demand that the best materials obtainable should be employed in road construction and maintenance, and more especially in the top stratum of metalling in contact with the traffic.

It has been held, hitherto, that a good foundation, with a covering layer of hard material, and a surface wearing stratum of good basalt, granite, or blue mountain limestone (according to the traffic requirements), broken to a 1½-in. or 2-in. gauge, properly consolidated with fine material and

water, to a curvature or cross fall of from 1 in 30 to 1 in 36, forms a sufficient surface for the purpose of a macadamised road. With the additional factor of suitable drainage, both for surface and subsoil, these principles have been closely followed in the more recent construction of our highways. Steeper cross gradients have also been adopted where softer materials than those enumerated have been used.

The use of metalling of larger sizes than those mentioned, has lately been practised on some roads carrying a heavy traffic in Middlesex, and under such conditions the increased size of the metalling has been productive of improved surfaces, and less dust and scavenging has attended its use.

There are several contingent considerations of importance and interest in connection with the use of road materials, viz., the geological formation of the area the local engineer has to deal with, and the neighbourhood, or country, in his immediate vicinity.

Jones may be stationed in one of the north-west counties of England, where there is a rainfall well over 100 inches during the year, whilst Robinson, in one of the eastern counties, experiences a rainfall much below 20 inches. Jones, with the advantages of basalts, granites, rocks, whinstones, etc., at his command, combined with the heavy rainfall, must necessarily possess greater facilities for securing good, sound roads, at a cheaper rate than Robinson, owing to the latter having to import the better class material he uses, principally from the Rhine, Belgium, Guernsey, etc.

Maintenance charges should be less in the former than in the latter instance. This is primarily due to the local conditions which obtain in the two differently placed areas, although in the north-west counties referred to, greater damage is liable to be intermittently caused to the road surfaces by the excessive local rainfalls usually associated with these neighbourhoods, than is experienced in the eastern counties.

Given a good sub-soil, a good foundation, good materials, consolidation, etc., a macadamised highway, formed upon proper constructive principles, should not be much affected when subjected to the mean rainfall of this country, provided a proper system of drainage has been devised to meet the ordinary requirements of each particular case.

In numerous counties of England and Wales however, many

miles of the more ancient highways exist, without either artificial foundations or underdrainage, and the road engineer has, necessarily, many difficulties to meet in this respect, which are not understood or appreciated by those outside the profession. It is only with a smooth, dustless surface that they appear to be concerned. How such a surface is obtained, to them, is another matter.

From personal experience, the Members of this Association are, no doubt, well acquainted with the many difficulties met with in securing funds for the purposes of providing existing carriageways with proper foundations and underdrainage.

In the majority of provincial (especially the agricultural) counties, it is as much as possible for the authorities concerned to obtain sufficient money from their rateable values (without thrusting undue burdens upon their ratepayers) to procure the best kind of materials for the ordinary maintenance of their roads, apart from improvement works, in connection with foundations, drainage, or widenings. In consequence, the major portion of the carriageways throughout England and Wales to this date, lack the one all-important factor in proper road formation—viz. a firmly packed foundation of broken rock, stone, or other suitable hardcore, with proper drainage facilities.

Some years ago, the Author, as a county surveyor, had charge of about 500 miles of main roads, outside the urban areas in one of the west-midland counties of England. For the purpose of being in a position to thoroughly advise the Council of that county in connection with a certain course they were taking, he caused test holes to be sunk about 400 yards apart along the main road carriageways (outside the urban areas) to obtain reliable information as to the nature and depth of road crust. It may be of interest to many of the Members present, to learn that the thickness of the metalling, or road crust, did not average more than 4 inches. Throughout the greater length no proper foundations existed, and the stratum of metalling carrying the traffic was, for many miles, resting only upon a clayey subsoil. To all appearances, with their beautifully smooth surfaces (obtained by the use of Clee Hill basalt, hand broken to a small gauge and steam rolled), the rural main roads throughout the whole of that county were strong enough to carry any weight, and it was only after a concentration of traction and other heavy traffic, that their actual weakness was exposed. This

state of things is, no doubt, to-day typical of hundreds of miles of rural main and district highways throughout England and Wales.

A road may be situated where flints or other poor quality materials are procurable at a fairly reasonable rate, without the additional cost of railway transit or water freightage attaching to the supply of good basalt, or granite. Flints, or poor quality stone, are consequently used, and, if the traffic be at all heavy, the result is that in the summer months the dust nuisance, under modern conditions, is unbearable; whilst in the winter months the road surface, especially after a frost, gives way considerably under traffic, and it is only by heavy expenditures of labour, fresh materials, and rolling, that the carriageway, so damaged, can be restored to anything like a decent condition.

Under such circumstances it will be found much cheaper in the end to import and lay down the more expensive basalt or granite, even with the extra freightage charges; and if this point were more often driven home in a forcible manner, to the members of the local authorities concerned, many miles of carriageway surfaces would doubtless be improved, and the existing dust nuisance greatly mitigated thereby. The Author is aware of the difficulty in this respect, and the feeling there is on the part of some members of local authorities to stint the supply of materials for roads, to the advantage of other local matters of probably much less importance.

The Author understands that a State Institution has been suggested, or formed, to initiate tests of different stones suitable for road macadam, in addition to which, as all the members are aware, tests of various materials assumed to be suitable for such a purpose have in different directions recently been made.

Recognising to some extent the value of the data obtained, showing the degrees of accuracy attaching to these tests, the Author thinks there is still much doubt as to the actual value of the various basalts, granites, syenites, trap rocks, quartzites, etc., now on the market as road materials. In the Author's opinion their actual value for the purpose of road maintenance can only be ascertained after a prolonged test under traffic, and climatic conditions.

Exemplifications of this view have been seen in the various urban and rural districts of the county of Middlesex, in which

the Author for some years past has been able to watch closely the effects of heavy wear and tear of roads, with varying foundations, under practically all conditions of traffic, upon which the results of published tests have by no means been upheld or confirmed.

There is a greater demand than ever for smooth hard wearing, dustless road surfaces, and whatever kind of material is used, it should, in the Author's opinion, be broken to as nearly a cubical shape as possible.

Wearing qualities of hand-broken materials are infinitely greater than the flaky stone produced by some stone-breaking machines. Except in a few counties, however, it is difficult to procure the former, owing to the shortness of labour obtainable in this particular line. The Author in this connection is inclined to the belief that the change to the use of so much machine-broken stone accounts to some extent for the prevalent dust nuisance and surface disintegration, with the consequent raising of small particles of metalling, especially by fast motor car traffic.

That disintegration takes place under light motor cars, with smooth india-rubber wheel tires cannot be gainsaid, and these tires cause more wear and tear to road surfaces than is perhaps appreciated. The passage of rapidly moving motor cars along carriageways, especially on which flints or poor quality materials are used, causes the particles of the detritus in the interstices of the metalling to rise to the surface, to be subjected to crushing by heavier vehicles with ordinary wheel tires, and so to create a large addition to the dust nuisance.

With a general use of basalts or granites, well steam rolled, first in a dry state, until a mosaic-like surface is obtained, and afterwards covered with ½-in. chippings of the same material as that used for metalling, blinded with fine machine chippings also of the same material, and well watered and rolled until thoroughly consolidated, the dust nuisance would be considerably reduced.

This method of sheeting resists much abrasion, with a minimum of wear by light locomotives and mechanical traffic, and obviates much disintegration.

It may not be out of place to state here that, in the Author's opinion, the most complete mitigation of the dust nuisance would be best obtained by the utilisation of some suitable agent in connection with basaltic or granitic road formations, or some

such hard wearing materials, so as to procure an asphaltic kind of road surface preparation, with a good foothold for horses.

The first cost in most counties of basaltic or granitic formations, untreated with asphaltic or bituminous compounds, leaves sufficient margin in cost to allow of some kind of treatment to ensure an efficient degree of waterproofing, at a rate favourably comparable with treated slag or limestone, and with a resultant life much longer than can possibly be obtained by the use of either of the latter materials under heavy traffic conditions.

Some such formation has lately been carried out on the Heaton Moor Road, near Stockport, Cheshire, and in the Stretford Urban District, Manchester, at what the Author understands to be a most reasonable first cost. In connection with these roads, the Local Government Board granted a loan for fifteen years, over which period the repayments of principal and interest extend. This extensive loan period is well worth the consideration of all present, for if the first cost is reduced to a common denominator per yard, it may be found that the system will, in the end, compare favourably with the cost attaching to the ordinary upkeep of basaltic or granitic formations. On these, over a given period, the labour bill would, no doubt, be much greater than that for the formation for which the Local Government Board have, the Author believes, given a fifteen years' loan period.

Such a system of surface covering would be found more expeditious than the laying of any kind of setts, or of the German process of small random paving, now being experimented with in this country. The time it would take to cover a road of any length (e.g. the road from London to Brighton), with either setts or random paving, would be enormous.

The Author has often thought that if the costs per square yard per annum for the main roads just outside county boroughs, cities, boroughs, and large urban districts, were reliably recorded, it would probably be found that, in some instances, it would be cheaper in the end to lay down wood paving, than to constantly sheet the road surfaces with either untreated, or treated macadam.

Maintenance charges connected with roads are commonly estimated, and compared on all sides on a per mile per annum basis. This, in the Author's opinion, is an unreliable system to act upon. If road costs are to be taken and compared with any

degree of accuracy, they can only be obtained by the engineer-in-charge on a square yard basis.

For some years past the Author has kept careful analyses of the costs of main highways, both urban and rural, on a per square yard basis, and the information so obtained has been of the greatest value to him, especially in determining the important points which are naturally and constantly arising in a county like Middlesex, with a rapidly increasing population.

Amongst other things, the Author has been able from the cost per square yard basis, to advise on many applications submitted to the county council, by the vested authorities in Middlesex, for contributions towards improved surfaces, and also for wood paving and asphalt, to be laid on numerous main roads. After such applications have been submitted to, and finally approved by the County Highways Committee and the county council, the capital cost of the work has usually been allowed, subject to the repayments of principal and interest instalments on loans raised by the several authorities applying, being charged in the annual main road accounts, which are submitted to the county council by the authorities at the end of each financial year, for audit and payment.

For wood paving on the main roads in Middlesex, creosoted deal, subjected to a pressure of about 40 to 60 lb. per sq. in. during the process of creosoting, and an absorption of at least 10 lb. of creosote oil to the cubic foot of timber, are the usual stipulations of the county council.

Many miles of such paving have been laid on urban main roads in Middlesex, and also in connection with the county light railways and tramways scheme, under the Author's supervision. The blocks used are usually 9 in. by 4 in. by 3 in. Their value for paving purposes and resultant life are practically the same as 9 in. by 5 in. by 3 in., which are more costly.

Creosoted deal is commonly known as "soft" wood of a resinous nature, and although its life is not considered by some to be equal to that of Jarrah (*eucalyptus marginata*) or Karri (*eucalyptus diversicolor*), it does not, perhaps, require so much cleansing and sanding as either of the latter, which somewhat counterbalances any loss of greater lasting qualities expected from Jarrah or Karri.

From a sanitary point of view also, the Author thinks that creosoted deal is better than hard woods. The surface of the

former wearing smoothly allows of scavenging operations to be carried out, better than when a road wears unevenly, as is generally the case with Jarrah or Karri.

The latter, no doubt, form excellent pavings in some localities, such as the Euston Road and other roads in the neighbourhood of the metropolitan termini of important railways, docks, etc., and also in areas in which the chief continuous traffic is caused by heavy vans, wagons, and omnibuses.

For the lighter traffic of the metropolitan area the Author inclines to the use of a less noisy and smoother wearing wood. Creosoted deal appears to possess these advantages.

Whenever and wherever wood paving of any kind is laid, it is obviously necessary that great care should be exercised in the selection of the wood, to see that it is thoroughly sound, well seasoned, free from sap, shakes, and other defects, and for the cement concrete foundations to be of a sufficient thickness for the traffic of the particular neighbourhood in which the wood is to be laid. The concrete and floating, too, should be thoroughly set before the blocks are laid. The latter appears to be a point much overlooked, and, in the Author's opinion, accounts in a great measure for the sinkages and badly wearing surfaces so often seen in all classes of wood pavements. In practice, it is usual, when wood-paving contracts are in hand, to employ a reliable man to watch both the cutting of the timber and the creosoting.

Some time ago the Author subjected several samples of Jarrah and creosoted deal to severe tests, when he obtained the following comparative percentages :—

	Expansion.	Contraction.	Absorption.
Jarrah	1·37	6·94	6·60
Creosoted deal	1·53	3·03	5·66

In these tests, as in tests for macadam, there must be, of course, some degree of inexactitude, and it is only in the actual wear and tear, under climatic and varying conditions, that reliable results can be obtained.

From calculations for repayments of instalments of principal and interest, with charges for maintenance, scavenging and watering, etc., on main roads carrying the heaviest traffic in Middlesex, the Author finds that when a road costs (inclusive) about 2*s.* 6*d.* per sq. yd. per annum to maintain in macadam, scavenge, water, etc., it is, in the end, as cheap to pave it with

soft wood on a Portland cement concrete foundation, as to continue the use of macadam.

The Local Government Board grant loans for creosoted deal paving to be repaid in five years, with twenty years for the concrete foundations. An equated period of nine years for the blocks and concrete together can also be obtained.

Five years cannot be considered to be the full life of soft wood paving, as there are roads in Middlesex paved with this material, carrying a heavy traffic, which have not been repaved for nine or ten years, and upon which the original deal blocks are still in a good condition. This factor must be taken favourably into account in considering the replacement of macadam by wood paving.

One result of the agitation referred to at the outset of this paper has been that a Departmental Committee has been sitting, and has reported, or is about to report, the result of its deliberations to the Government.

With regard to the point which has been raised by those agitating, as to which is, or which is not, the better method to be adopted for the efficient management of the roads of this country, whether by a direct scheme of centralisation through county councils, or through a traffic board, appointed specially by Government, the Author as an engineer to a county council is naturally precluded from offering any opinion. He thinks, however, that he may be fairly allowed to say on behalf of the Members of the Association, that if the Government should decide that a change of administration is necessary, sufficient intelligence will be found to exist amongst the present executive officials throughout the country to give a good return for the expenditure which must necessarily be incurred, to place the roads in the different counties on a standard sufficiently high to satisfy, particularly, the requirements of those bodies agitating for a general reform.

Taking the position brought about by the advocates for this reform, the Author is bound to say that it appears regrettable that so much notice should be taken by those in authority of the remarks made by some, whose experience of actual highway maintenance and management cannot be based on anything but a theoretical knowledge, obtained chiefly from their observations in travelling the roads of the country, on behalf of outside associations, or as motorists on pleasure bent.

Those who have the control and upkeep of the provincial roads of this country know only too well that the finances of their authorities cannot stand the increasing expenditures and taxation necessary for improved surfaces, and to demonstrate the futility of what the societies who are agitating for reform expect, the Author divides the latter, and will, hereafter, refer to them as Bodies Nos. 1, 2, 3, and 4.

Body No. 1 appear to desire that all the roads and bridges throughout the country should be of a standard sufficient to carry all the weights that can be thrust upon them, under the Highways' and Locomotives' Acts, and Amendment Acts.

Body No. 2 appear to desire that all the roads and bridges throughout the country should be of a standard sufficient to carry all the weights and impositions of the Light Locomotives' Acts, and Amendment Acts.

Body No. 3 appear to desire that all roads throughout the country should be constructed of waterproof materials so that the dust nuisance may be reduced to a minimum, whilst

Body No. 4 appear to desire to see the 1850 existing road authorities at present in England and Wales abolished, and a new system of road management, either through county councils or through a traffic board (especially appointed by Government), inaugurated with a view to a general improvement in the standard of roads throughout the country.

The Author sees, under any circumstances, very grave difficulties in the way of any drastic change for the betterment of roads under the existing local taxations, and if any such change of administration, with a view to improved foundations, drainage, surfaces, or widening improvements, is decided upon, it can only be achieved through extra grants from the Imperial Exchequer.

It is admitted on all sides that, since the advent of county councils, the rural main roads of this country have been greatly improved, and Bodies Nos. 1 and 2 have little fault to find in this connection. Bodies Nos. 3 and 4, however, if the Author understands rightly their ideas, are far from being satisfied, and, like "Oliver Twist," are asking for more. Their insistence shows that before they can be satisfied roads with waterproofed surfaces are expected to be furnished.

With a view to some final opinion in this direction, and the material best suited to this end, the Author for some time past, has, with other Members of this Association, been carrying out

experiments with various kinds of waterproofing materials, including tar painting (a very cheap method), tarmac, tarred macadam, tarred limestone, cement and macadam, and other admixtures, to secure a coating which will withstand penetration, and atmospheric influences.

The Author believes, that up to the present time, no general consensus of opinion has been formed on the subject by those who have experimented, and whatever material is finally accepted as the best suited in all respects for the purpose, a very large expenditure must, necessarily, be made in re-coating even the lengths of the main roads through the villages and populous centres of this country, to obtain some consummation, in this direction, without taking into consideration the remaining lengths of main roads, outside such areas.

The provision of even short lengths of waterproofed carriageways through the said villages, and populous centres, must, in some way, form an addition to the burden already resting upon the ratepayers, which burden will necessarily be intensified, if such waterproofed roads have to be universally provided.

It is stated by some that a general improvement could be effected in connection with the dust nuisance, if the main roads of the country were swept and scavenged oftener, whilst others assert that watering (especially at night) would mitigate the dust evil. There are also writers who state that an admixture of tar and soft materials would probably tend to improve surfaces.

To any practical mind, it is obvious that these suggestions have emanated from those belonging to the class, who claim to possess the knowledge of competency, to teach the business of road maintenance, to those Members of this Association, who have practically spent their lives in the actual practice of the subject.

It is more than most provincial counties can afford, to water during the day, without the luxury of night watering in addition; and sweeping of rural main roads cannot be practised, under present financial conditions.

The Author is not sufficiently dogmatic in his views to say that there is not a want of better carriageways for the mechanical traffic, already referred to in this paper, but he does state emphatically, that very much better highways generally than those at present existing, can only be obtained by extra Government grants, and to obtain this object, increased taxa-

tion throughout the country will perforce become inevitably necessary.

As a motorist, the Author has great sympathy with the object for providing water-proofed roads for motor car traffic and it is quite clear that the latter must be met and provided for in some way or other. Motor cars have come to stay, and an improved standard of road construction and maintenance, at a reasonable outlay, must be the chief aim. In this, road authorities must be supported by manufacturers of cars, with a view to producing vehicles of, as far as possible, a non-dust-creating type. With co-operation in this direction, the burdens of the taxpayer will be lighter than otherwise.

Some time ago the Author had the privilege of giving evidence before the Departmental Committee on heavy motor car traffic. In the proof of his evidence he stated that, at a moderate estimate, if the main and district roads throughout England and Wales had to be strengthened to sustain the weight it was suggested they should carry, the following estimated expenditures would become necessary:—

	£
On rural main roads	80,334,560
On district roads (rural districts)	184,607,760
On district roads (urban districts)	22,758,480
	£287,700,800

The main roads in urban districts are not dealt with in these figures, which are based on the exact mileage of rural roads given in the published returns.

From a long experience of the subject, the Author believes the figures given are fairly approximate.

Some such expenditure may also be fairly expected as approximating to the amount necessary for dealing with the motor car traffic of to-day.

Since the figures were given to the Departmental Committee, the Author has gone a little further, and finds that, from the returns last June, there were in use at that time in England and Wales about 27,674 motor cars and 30,729 motor cycles; taking the combined population of England and Wales at 33,000,000, these figures reduced, give 1 motor cycle to 1073 persons, and 1 motor car to 1192 persons. There has since been a large increase in the number of cars licensed.

From personal experiments made with the car he uses, the Author is fully satisfied that up to a speed of from 12 to 15 miles an hour, there is little more dust than would arise from a horse and trap travelling at the same rate, but beyond this speed the dust increases in the ratio of the rate of travelling.

From experiments with several hired cars, the fact also presents itself that the higher the body of the car is above the road surface, the less dust it creates. Manufacturers can, therefore, assist towards improving matters if they try.

Those in charge of roads would do well to consider the modern traffic requirements in connection with road curvatures. Too much road camber does not always conduce to economy in road maintenance, and there is no doubt that excessive cambers cause great strains on the rim attachments of mechanically propelled vehicles, to the detriment of both road surfaces and vehicles.

Traffic requirements are rapidly changing in character, and it will only be by a close study of the correlation of modern mechanical propulsion to road surfaces that maintenance difficulties will be minimised.

Non-skid tires with small steel studs are now much used for motor cars, and from the Author's experience, he finds that such tires do not raise so much dust as smooth ones, although, perhaps, those studded do more damage to roads than tires of other makes.

From observations and experiments it appears to the Author that more attention should be given by manufacturers to the underside of motor cars. A great deal might be done towards a mitigation of the dust nuisance if car bodies were built on lines which would prevent the excessive air currents caused by fast speed. The clouds of dust now so prevalent and disagreeable to the ordinary and pedestrian traffic, are no doubt greatly the result of such currents.

With further reference to the road experiments already referred to, it appears to the Author that whatever they prove the result cannot be of much final value owing to the enormity of the expenditures necessary to renew the whole of the carriageway surfaces of this country, and it is only a gradual improvement in their standard that can be aimed at.

The question is, how can this object be obtained?

Putting the average cost of the upkeep and maintenance of

the rural main roads of England and Wales at 60*l.* per mile per annum, and reducing this amount, it will be found that about 2¼*d.* per sq. yd. is the annual cost now incurred in this connection.

Road watering on rural main roads directly maintained by the county council of Middlesex costs about 1*d.* per sq. yd. per annum.

Assuming that watering was generally adopted on all the rural main roads of the country, the present cost of their upkeep and maintenance would be increased accordingly. In this consideration the great difficulty in obtaining water must also be remembered, and also that scavenging operations would be to some extent increased.

Rural main roads cannot be dealt with as those in urban areas. In the latter, water can usually be obtained from either companies or town supplies, but in rural centres there are more often than not, very long lengths of main roads for which water can only be obtained from streams, ponds, or ditches, and frequently in hot seasons, when the water is mostly required, these are found to be dry.

Permanent relief by watering is therefore, under existing conditions, next to an impossibility.

Tar painting road surfaces has been much practised by the Author and others, during the past three seasons, as a remedy for the dust nuisance, which method of treatment has been most successful. The actual cost in Middlesex of this work has been about 2*d.* per sq. yd., inclusive of tar, pitch, labour, and sanding.

Apart from a dust preventative, tar painting undoubtedly preserves road surfaces, and it is to be regretted that a method of painting or covering of some sort of bituminous material, which would be much more lasting and effective than the simple coating of pitch and tar, has not been obtained by those members of the Association who have time for thought and extended experiments at their disposal in this connection. A great want of something in this direction is to-day being universally felt.

The cost of tarred slag macadam, tarred limestone, etc., as surface coverings, is, perhaps, too great to admit of their general use. The preparation of the old main road surfaces for the reception of either, with the contingent cartage and labour expenses, probably makes the cost per sq. yd. prohibitive for general use on rural main roads.

Other agents for remedying the dust nuisance have been experimented with in Middlesex, but none of the preparations used have been found to be so effectual as tar painting, and the best solution of the dust problem lies, the Author believes, in the direction of efficient liquid bituminous coverings, combined with a use of the hardest wearing road materials procurable.

In the county of Middlesex the amounts expended annually upon main roads and footpaths have risen from 49,000*l.* in 1889 to 90,391*l.* for the year ending March 1905.

The Author commenced in 1898 to keep careful analyses of the cost of such roads in Middlesex, under various headings, and the returns at present show that 5½*d.* per sq. yd. is the average of the county for scavenging and watering only of the urban main roads for the year ended 1905, against an average of 4¼*d.* per sq. yd. per annum for the year ended 1900. These increases are no doubt somewhat typical of those in other counties, and the Author invites discussion, particularly in this direction, to show that the users of the carriageways are being, at any rate, to some extent considered.

The average cost of the total maintenance, scavenging, watering, etc., of the macadamised urban main roads in the county of Middlesex works out at about 1*s.* 0½*d.* per sq. yd. per annum, and the average cost of such works on the rural main roads directly maintained by the county is 5*d.* per sq. yd., which, no doubt, compared with other counties, will appear to be exceedingly high. It must be remembered, however, that the rural roads of Middlesex carry a very heavy and constant traffic, and are constantly watered and scavenged similarly to the urban main roads.

With a view to improving important cross country roads, the county council of Middlesex have recently created a second-class subsidised carriageway. There are now three classes of roads in which the county council are interested, viz.: (1) main; (2) subsidised (class "A"); and (3) subsidised (class "B"). The county council pay practically the whole of the annual expenditures on the former, and towards the upkeep of the two classes subsidised 50 per cent. and 25 per cent. respectively, are annually contributed. The grants to subsidised roads average about 12,000*l.* annually—the length of such roads being about 47½ miles.

The Author is strongly of opinion that a solution of the

difficulty in regard to obtaining a gradual improvement in the roads generally of this country, lies in some such system of classification, or standardisation, with accompanying subsidies, and that the latter should be supplied from funds provided by Government, for the particular purpose of assisting county councils to subsidise roads of different classes.

Whether the Government decide to legislate in the direction of a change in the present systems of road administration, remains to be seen, but if so, grants from the Imperial exchequer to county councils, or a central body (if one be created), can only, in the Author's opinion, satisfactorily solve the difficulty, and gain the end in view.

Neither a county council nor a traffic board would be upheld in devising a system of waterproof roads, regardless of cost, for the benefit of any special user.

With regard to road widenings and other improvements, the Middlesex county council have, during the period from January 1904 to March 31, 1906, agreed to contribute 86,536*l.* to this object. The vested authorities create loans to carry out the improvements (first approved by the Council) into effect. As before mentioned, the instalments of principal and interest, for repayments of the loans raised for such works, are allowed to be charged by the various local authorities in the annual main road accounts submitted to the county. If the Government should desire improvements to be carried out generally, in connection with cutting off bad corners, or in widening narrow parts of main roads, there is a large field where Imperial subsidies could be well expended by the existing county councils and other authorities.

With regard to the proposals which have lately been put forward with a view to a large outlay being incurred to carry out a general scheme of extensive road widenings, motor roads, trunk roads, twin roads, roads for light and heavy traffic, etc., if the expenditures incurred (apart from the amount of 86,536*l.* already mentioned) in connection with the road widenings now being carried out, to accommodate the large scheme of light railways and tramways at present being constructed in the county of Middlesex, form any criterion, the Author, from his experience as engineer of the scheme, is most confident that the finances of the county cannot stand the calls hat must necessarily be made upon them to effect such a purpose.

The Author hopes that this paper, brief as it necessarily is owing to time requirements, will be the means of ventilating a subject which, at the present moment, is important not only to the Members of the Association, but perhaps also to the country generally.

DISCUSSION.

Mr. W. HARPUR: I should like to move a hearty vote of thanks to Mr. Wakelam for his paper. Mr. Wakelam has not been strong enough in his remarks when he says in his paper "that it appears regrettable that so much notice should be taken by those in authority of the remarks made by some whose experience, etc." I should say if he had put in the *ignorant* and *senseless* remarks, it would not have been too strong, particularly taking into consideration what these people have said. I believe the question of dust prevention is more a matter for county surveyors than for those of us who have urban roads to maintain. It is on the county roads that the dust nuisance is most observable. There is one matter which is particularly serious—I refer to the heavy locomotive traffic which is now permitted on the roads, and Mr. Wakelam has touched upon the unsuitability of most of our roads to carry the heavy road locomotive traffic. The only way of surmounting the present difficulty is by reconstructing the road foundations, the cost of which will necessarily be enormous. Then the question arises as to whether the advantage accruing to the owners of these heavy vehicles is in any degree beneficial to the great mass of ratepayers upon whose shoulders will be thrown the burden of the great expenditure facing us. Another point is the reluctance of road authorities to sanction the spending of sufficient money for the proper upkeep and maintenance of our highways. I rather think that to-day the highways are being starved.

Mr. A. DRYLAND: I have pleasure in seconding the vote of thanks. The paper brings before us a very interesting problem in which county surveyors are especially concerned. I think the crux of the whole matter rests upon the point raised by Mr. Harpur as to the cost, and the source from which the money is to be found, I cannot help thinking that the circumstances of the roads and the manner in which the money is raised, will

both have to be changed. There was a time when the roads were used chiefly for local traffic purposes: but the same cannot be said now. Therefore we want a change in the method of raising the money. I think it will have to be moved from local shoulders to those of the whole community. I happen to be responsible for the roads in a county depending entirely upon agriculture, which is not one of the most paying businesses in the country. The rates are paid chiefly by the farming interest, and they are exceedingly loth to increase them in any way for the up-keep of the roads, and more especially do they feel it a hardship to do so for the use of people outside their own locality more than for their own use. For all purposes of agriculture and the common traffic, the roads satisfy all reasonable requirements, and the dust nuisance did not exist until the advent of the motor car. Now they are told they must make their roads dustless. That is a very large order, and I argue that the cost ought to fall upon those who want the advantages, or who have rendered the change necessary. I agree with Mr. Wakelam's remarks as to the scientific tests of different kinds of stone. I have no doubt they have a considerable value, but after all their ultimate value can only be tested by practice, and under different circumstances and conditions. Those who have a large mileage of roads to maintain know perfectly well that a metal which stands well under one set of circumstances does not do so under another. The position in which the material is to be used, whether it is to be laid on an open road, under trees, on a gradient, or on the level, has a most important bearing on the wearing quality of the material, and it is impossible from the laboratory test to say with certainty the material will stand well in any particular situation. A little further on Mr. Wakelam makes references to the wearing qualities of materials broken by hand and machine respectively. I think he is right in saying there is more dust from machine broken, than from hand broken stone. I think the stone is affected more by machine breaking, as it gets split up into narrower pieces, and its life is decreased. It is also more likely to be crushed from its being less cubical in shape. With regard to the binding materials, I agree that chippings of the same materials are the best. I have tried almost all gauges of chippings of road materials. I think that a mixture as it comes from the breaking machines of about 1 in. to dust is the most satisfactory. With regard to the making of

all roads waterproof, that is a desirable thing to have in view, but I don't think the problem has yet been solved how to do so at a reasonable cost. As to removing dust from the roads by machinery, that must be done with great caution, because in dry weather, if you remove the dust too frequently, you will cause the surface to break up, and have loose stones lying about which will be almost as unsatisfactory as dust. As to tar painting, I must say it does preserve the surface to a considerable extent. Some twenty years ago I tried it and found it increased the life of the material considerably, and was very satisfactory, except in winter. When the damp foggy days come, and severe frost, the tar painting will in some cases break up, and cause a nasty mud, which we shall be glad to get rid of, but I am quite sure that a great deal can be done to lessen the dust nuisance by tar painting. Mr. Wakelam refers to the heavy cost of road widening and improvements. That is a matter which if extensively taken in hand, would run to immense sums, and I do not see any possible means of obtaining the necessary money. There are many country roads which are sufficiently wide for the traffic which has been upon them hitherto; they may not be wide enough for the new traffic, but their widening and improvement cannot be afforded by the present ratepayers, and some new means of taxation will have to be devised, I think, as to motor cars; those who benefit by their manufacture and use, should contribute some considerable proportion of the cost of road improvements and dust prevention, at any rate, until such time as motor cars become the general mode of traffic throughout the country.

Mr. R. Brown: A correspondent recently said there were three types of roads, first the roads not treated, then those treated by water, and those which are tar painted. Of all the three he condemned most strongly the tar-painted roads. He said that method made such a filthy mess on the roads that it was worse than the untreated roads. He went on to say that watering was most satisfactory in keeping down the dust. I think if that gentleman was here he would come to the conclusion that it is impossible to water the country roads in such a way as to keep down the dust. You will have to find something which is cheap and effective for dust laying. That material, I think, I have been able to discover. It is known as oil tar. I use a liquid containing some 95 per cent. of oil tar, and only

5 per cent. of water. This is a most important point, as to this fact is due the success of dust laying. The cost is 1*d.* per gallon. The liquid is put on the roads by means of the ordinary water cart, having the side holes stopped up so as to prevent as far as possible the liquid being spread upon the side-walks. The road is first thoroughly swept and the dust picked up, and after the liquid has been applied, the men go over the surface with brooms, well rubbing the liquid in. The appearance of the road after the liquid has been applied is that of a newly-laid wood pavement (creosoted deal), and has the same odour. For main roads it is advisable to put on the liquid during the night, so as to cause as little inconvenience as possible to the traffic, but the side streets may be treated during the day. I first tried *drenching* the road with the liquid, and this worked out at $\frac{1}{4}$*d.* per super. yard, including everything—labour sweeping up the dust, carting, spreading the oil, etc. The treatment is good for —if done in this way—from four to five weeks, and shows a very great saving even in the cost of watering, without counting anything for the absence from dust, the deadening of the noise of the traffic, the preservation of the road surface, absence of mud in wet weather, and the powerful disinfecting qualities of the liquid. I am now putting on the liquid in a slightly different way, that is, instead of drenching the road at the first operation, I am passing the water carts over the roads—with the liquid once only, and giving another dressing at the end of a week. I am not however sure but that the first method is the better and more effective for the purpose. Of course, the subsequent dressings do not require so much liquid. I estimate that we shall require some five waterings or dressings during the summer months, and this will cost about 1*d.* per super. yard in all. Watering by the ordinary means costs very much more.

Mr. W. B. PURSER: This special treatment of the roads by oil tar seems to be the millennium at last. I doubt it. I have seen a good deal of treatment of the roads by oil, and if immediately after treating the road there happens to be a storm, the oil will be washed into the streams. The cost of treating the roads with oil tar would not compare with tar painting. Tar painting the roads can be done easily for a 1*d.* or 1$\frac{1}{4}$*d.* per yard, and on country roads it will stand well for upwards of twelve months. I can show you roads which I tarred fifteen months ago, on which the tar is easily discernible, and if a motor

car goes over those roads at thirty miles an hour, it does raise some dust, but it is not dust which has been made on that particular length of road, but dust which has been blown on from the continuation of the road at both ends. As to the attrition tests, I fear they are more likely to mislead than to help any surveyor who follows them. The stone which goes first into the testing machine gets by far the roughest treatment, as the angle irons in the cylinder have all their sharp edges intact, and it follows, after three or four tests have been made, as other stones are put in the sharp edges become rounded, and therefore cannot make as much dust or grit. The results given by laboratory tests of this character do not indicate in any way the wearing qualities of the stone as applied to the roads. I think there is too much stress placed upon the condition of the foundations of the roads, whether sand, gravel, or clay. It does have some bearing on the condition of the road, but no matter what may be the foundation, you want the best possible stone on the surface of the road. You cannot make a bad stone wear well even on a good foundation. The foundation ought to be considered, and will be considered by every practical engineer, still, only the best stone for the coating can give really good results on the roads. I should like to know whether Mr. Wakelam has tried basalt or granite with tar treatment. I do not think basalt is likely to give good results with tar treatment. The only stones which apparently can be successfully treated are the slag and the limestone, and I should very much doubt if any granite can be successfully treated. I think the portion of the road, referred to by the Author, at Heaton Moor is tarred slag and not tarred granite. Referring to the comparison of cost of material, I do not understand why the Author should prefer to make his comparisons by the yard instead of by the furlong or the mile. Mr. Wakelam says that when a macadam road costs 2*s.* 6*d.* per square yard to maintain, it is as cheap to pave it with soft wood. That is absolutely an outside figure for macadam. It works out at about 2000*l.* per mile per annum, with a road 8 or 9 yards in width. In my county I get about 60*l.* or 70*l.* per mile per annum, which has to cover everything. If I could get 2000*l.* I do not doubt that I could make roads even equal to those of Middlesex. I was formerly in charge of a road which has perhaps the heaviest traffic of any road in England, the road from Failsworth to Manchester. Part of that road is macadam

and part paved with setts, and that cost from 400*l.* to 450*l.* per mile per annum. I think surveyors have wakened up considerably since the sensible or senseless criticisms have found their way into the press. Then I do not quite understand why the Author should go to Switzerland for examples of tar painting. Mr. Dryland said he did it twenty years ago, and I tried it many years ago. I do not think the English surveyors have much to learn from the foreigners as regards road maintenance. I rather hesitate to think that we should go to France, Germany, or Switzerland for lessons in road making. I think it would do the Continental engineers more good to come and see the splendid roads we have in this country, and it would be well if the press would advise them to do so. I should like to know whether Mr. Wakelam considers that the addition of pitch to tar is an improvement. To my mind pitch would make it more inclined to come away from the road surface, as it would probably add to its brittleness without increasing its adhesiveness. I have painted a considerable portion of the Great North Road at a cost of 1⅛*d.* per yard. In reference to the laying of tarred slag macadam, I should like to ask Mr. Wakelam what preparation for a foundation he considers necessary. All I do is to brush the dust off the existing surface, and if it is a very porous road, tar it, and then lay my tarred slag on the top. I have not had a single yard break up, and I do not think that one could have a better foundation than a road of fifty or sixty years standing.

Mr. W. H. Leete: I have in the county of Bedford two main trunk roads running from London to York, and also the Watling Street road, running from London to Holyhead. The breaking up of the roads—or, rather, the disintegration of the surface of the roads—by light motors has been a very serious matter to us as a county, and there is no doubt that the cost of our upkeep has been very considerably increased thereby. There was an observation made by Mr. Harpur about the very heavy motor traffic. We have had instances of boilers of very considerable weight being carried over the Watling Street road. That road is one of Telford's make, and a portion of it is built with sandstone boulders upon a clay base. It was a good road for all the traffic of the district, until these heavy multitubular boilers were brought over it, instead of being sent by rail, and the result was that the weight, which was well above 8 tons per wheel, caused the clay to be pressed through the surface,

and the road went under the weight. The cost of restoring the road was a very considerable item. Such traffic ought not to be a charge upon the local authority. The Government ought to protect the local authority from the enormous charges which such traffic involves. We have brought claims against the offenders, and have had a small amount paid in compensation. The great cost of repairing the road and putting in a foundation to carry such weights is a very serious item indeed. With regard to the dust nuisance, we have in the county of Bedford the same difficulty, and we have resorted to tar painting. I can confirm what Mr. Purser has said that the tar painting, which costs us about 1*d.* per yard, lasts the whole of one season. It certainly becomes rather a nuisance about February, when we get neither sun nor wind, and is a bit of a difficulty, but I find that when March winds come in, the material which was rather offensive in February, has become perfectly settled, and has been a useful preservative of the road in winter. We are doing a good bit of tar painting because the roads operated upon last year were so much appreciated that my Council are extending this operation. With regard to tar macadam, I may say I have laid tar macadam down for thirty years, and have always made it of the best quality of ironstone slag. It is the best absorbent of the tar, and I have no hesitation in saying that if tar macadam be properly made, with gas tar sufficiently boiled, and the stone sufficiently heated, it is a very desirable and lasting material. About two years ago I put tar margins to some roads of a semi-urban nature, and it cost about 2*s.* per yard for material 3 in. thick laid upon a good hard base. That answered admirably. With regard to the attrition test spoken of, I quite agree with the observations of Mr. Purser. I find that the two quarries mentioned as producing the soundest stones, and standing the largest amount of wear from the attrition test, are really stones which I myself cannot use, as they are ground up very quickly. I think the time ought to be near when motor cars should be built well above the road surface, as I am satisfied that if that were the case we should have very little dust nuisance. The other day I was riding from Bedford to Huntingdon on a car which was built well above the road, and the dust rising from that car was very small indeed. I am using on my tarred roads the fine slag dust, which immediately takes up the tar; it makes a very nice surface, deadens the

sounds, and is a great preservative of the road. It may be interesting to the Members to know that the tar does go down even to the bed of the stones. I had an example of that only the previous Monday when in the town of Woburn, where we are painting the roads for the Duke of Bedford. They are county roads, but he has given us instructions to tar them at his cost. As to drainage done in winter time, it is the main cart-way which suffers. The sides of the road are scarcely damaged at all, so the renewal of the tar painting is confined to the centre of the track, and the cost the second year is not more than half the cost of the first year.

Mr. WIKE writes: Mr. Wakelam, I notice, recommends the use of dust as a binding material, but on this point I am afraid I can scarcely agree with him. From motives of economy dust may have to be used, but dust it remains, and under the best circumstances we get too much of this. I am inclined to think more watering and rolling, when the macadam is laid, and less blinding material would minimise the amount of dust—and possibly the complaints about it. The Author's opinion that the true value of road materials can only be determined by practical tests under traffic is a sound one. As bearing this out, I may mention that for fifteen years I have kept under observation for testing purposes a length of dry macadam road with a gradient of 1 in 14, without cross roads, divided into three sections, coated with granite, furnace slag, and limestone respectively. The annual cost per square yard, exclusive of watering or cleansing, has worked out as follows:—Granite, 6·23*d.*; slag, 7·28*d.*; limestone, 8·91*d.* Mr. Wakelam mentions that when the total cost per yard reaches 2*s.* 6*d.* per annum, it may be more economical to pave. I have had figures taken out for four important main roads leading out of the city of Sheffield, all macadamised with granite, commencing at points two to three miles away from the centre of the town area, where generally the tramways and paving terminate, and find the annual costs per square yard, including sweeping but not watering, amount to 4·57*d.*, 5·60*d.*, 6·37*d.*, and 7·30*d.* respectively—average almost exactly 6*d.* It would be interesting to compare these figures (which for the class of road are probably low), with those for other districts. They seem to be about the Middlesex standard.

The vote of thanks having been passed by acclamation,

Mr. H. T. WAKELAM, in reply, said: I wish to acknowledge

the vote of thanks which you have so kindly passed to me for the paper. I quite agree that some of the roads of this country are being starved for other purposes. Mr. Dryland referred to the extraordinary cost devolving upon provincial counties in the upkeep of the main roads. A point occurred to my mind while Mr. Dryland was speaking as to the decreasing rateable value in some counties in England, owing to agricultural lands and farms being unoccupied. I think the point should be a great factor in connection with any Parliamentary committee as to taxation upon local owners. Mr. Brown gave us some very interesting particulars about a system which he has lately inaugurated of using oil tar on the roads, which is worth considering. On one of the most important trunk roads of the county of Middlesex, we painted the surface about May of last year with a mixture of tar and pitch, which Mr. Purser seems to disparage. That lasted until the end of September. As a matter of fact, it lasted longer on the sides of the road, for it was only on the centre of the road that the tar painting was disturbed during the winter months. Mr. Purser advocates the measurement as to maintenance cost by the furlong, which is practically the same as the mile measurement. I say that a furlong or mile measurement is not the proper basis to go upon. Generally, the comparison is taken upon the mile measurement. But you cannot compare a mile of road in Cumberland with a mile in Essex. For instance, we get returns sent in to us from different counties of the cost per mile, so much for urban roads and so much for rural roads. The returns are in reality of no value, because the material may cost 50 per cent. less in Cumberland than in Essex, and your labour bill may be 30 to 40 per cent. more in one county than another. There is no comparison between the cost of a mile in one part of the county with a mile in another part even of the same county. Then the mile or furlong basis is altogether wrong, because it ignores the width of the road, and the facilities one county may possess in obtaining materials from local quarries. I cannot quite agree with Mr. Leete as to slag being the best material for tar macadam roads. My experience is that slag does not absorb the quantity of tar it is generally supposed to absorb. I cut into a tarred slag road recently and found the tar had not penetrated the material more than the thickness of a sheet of paper, and the material was not at all impregnated. Mr. Purser raised a question as to which I con-

sidered the material best for tarred macadam. Some seventeen years ago I laid a road in the neighhourhood of Liverpool with Belgian granite and limestone chippings mixed with tar, pitch and creosote oil. Mr. Brodie has been good enough to tell me that they in Liverpool are only just replacing that material. If Belgian granite will last seventeen years, I should say that either basalt or granite properly treated will last the same number of years. Mr. Purser also raised a question as to the road at Heatonmoor. That road has been made with Dalbeattie granite and some form of asphaltic preparation. The Local Government Board were so satisfied with it that they, I understand, have given a loan for fifteen years for it. With regard to Mr. Purser's remarks as to the cost per super yard of road, his experience must have been limited to somewhat inexpensive roads, otherwise he would be able to judge better the cost of the upkeep of the roads in and around the metropolis and other greatly populated cities. If macadam is to last and be waterproofed on the surface, we shall have to have asphaltic mixtures for treating granite and basalt so that such waterproofed surfaces may be obtained, and which will withstand not only light but heavy traffic, for a sufficiently long period to repay the extra cost the waterproofing entails over and above ordinary granite or basalt coverings.

On Thursday, June 28, the Members dined together at the Holborn Restaurant, Mr. J. Patten Barber, President, in the chair.

At the close of the discussions on Friday, the Members proceeded by motor omnibuses to Brentford. Here the urban council's spacious new market was inspected under the guidance of Mr. Nowell Parr, who explained the chief features of the work. The drive was then continued by way of the Royal Gardens, Terrace Gardens, and Richmond Hill. The next inspection was that of the workmen's dwellings erected by the Richmond Corporation. Here Mr. Brierley, the Borough Surveyor, acted as guide. Several of the houses were carefully inspected. The party then drove to Mortlake, and en route opportunities were given to inspect lengths of roads treated with dust-prevention compounds. At Mortlake some time was spent in inspecting, under the guidance of Mr. Fairley, the Richmond Main Sewerage Board's works, which include both chemical-precipitation and bacterial processes. The

steam and electrical pumping machinery, the petrol locomotive for the sludge and other trucks, and other interesting features of the now well known works, were all examined with close attention. The high standard of excellence with which the arrangements were kept up was very unanimously noted.

Under the pilotage of Mr. G. B. Tomes, the party then proceeded to inspect the electricity station, fire station, and depot of the Barnes Urban District Council, afterwards returning to Westminster.

Saturday, June 30, was occupied by a visit to the works of the Associated Portland Cement Manufacturers, at Northfleet. The party was formed into sections, and every opportunity was afforded the visitors to inspect all the details of the manufacture, Mr. F. A. White, the chairman of the company, Mr. Bamber, and other directors acting as guides. At the conclusion of the inspection the Members were entertained to a luncheon, at which Mr. F. A. White, presided.

APPENDIX.

STATISTICAL RETURNS

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W. Those marked thus * are in duplicate, and can be borrowed for perusal by Members on application to the Secretary. Those *not* marked * can only be inspected at the Offices.

N.B.—PLEASE QUOTE REFERENCE NUMBER.

(Members are requested, when kindly sending statistics, to do so in duplicate if possible.)

Ref. No.	
	ABATTOIRS (PUBLIC).
12	Compiled by W. Chapple Eddowes, Shrewsbury. 1902.
	CEMETERIES (PUBLIC).
53	*Compiled by H. Richardson, Handsworth. 1904.
	DRAINAGE CONNECTIONS (PRIVATE).
11	*Compiled by H. Richardson, A.M. Inst. C.E. 1902.
	DRAINAGE (HOUSE).
1	Compiled by J. Atkinson, A.M. Inst. C.E., Stockport. 1894.
	DRAINAGE (NEW BUILDINGS).
49	*Compiled by E. J. Lovegrove, M. Inst. C.E., Hornsey. 1896.
	FIRE BRIGADES.
36	Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.
	HOSPITAL (INFECTIOUS DISEASES).
59	*Compiled by J. Walker Smith, Barrow-in-Furness. 1905.
	LABOUR, CONDITIONS OF.
63	*Compiled by A. E. Collins, Norwich. 1906.

Ref. No.

LIGHTING (ELECTRIC).

3 Compiled by J. W. Brown, A.M. Inst. C.E., West Hartlepool. 1894.

4 Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1891.

5 Compiled by W. A. Davies, A.M. Inst. C.E., Aston Manor. 1893.

40 Compiled by E. J. Silcock, A.M. Inst. C.E., King's Lynn. 1896.

LIGHTING (GAS).

6 Compiled by J. W. Bradley, A.M. Inst. C.E., Nelson. 1895.

7 Undertakings in the hands of Local Authorities. Compiled by P. Ross, A.M. Inst. C.E., North Bierley. 1896.

LIGHTING (PUBLIC STREET).

8 Compiled by A. H. Campbell, A.M. Inst. C.E., Canterbury. 1895.

9 Compiled by C. C. Smith, Dalton-in-Furness. 1892.

48 *Compiled by E. J. Lovegrove, M. Inst. C.E., Hornsey. 1900.

54 *Compiled by A. E. Nichols. 1903.

LIQUID NIGHT SOIL (DISPOSAL OF).

38 *Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.

MOTOR WAGONS (UTILITY AND WORKING OF).

57 *Compiled by J. Walker Smith, Barrow-in-Furness. 1905.

58 *Compiled by R. J. Angel, A.M. Inst. C.E., Bermondsey. 1903.

PAVEMENTS (COMPARISON OF LIFE AND COST OF GRANITE AND GRITSTONE).

10 Compiled by C. F. Wike, M. Inst. C.E., Sheffield. 1890.

PAVEMENTS (TAR MACADAM).

46 Compiled by A. E. Collins, A.M. Inst. C.E., Norwich. 1896.

47 Compiled by J. Hall, M. Inst. C.E., Cheltenham. 1896.

41 Compiled by E. A. Stickland, A.M. Inst. C.E., Windsor. 1897.

Ref. No.	
	PRIVATE STREET IMPROVEMENTS (CONSTRUCTION OF WORKS OF).
13	Compiled by W. J. Newton, A.M. Inst. C.E., Accrington. 1892.
56	*Compiled by T. J. Rushbrooke, Chepping Wycombe. 1905.
	PUBLIC BATHS AND WASHHOUSES.
42	*Compiled by P. Edinger, Frome. 1897.
55	*Compiled by J. Walker Smith, Barrow-in-Furness. 1905.
	REFUSE (COLLECTION OF).
14	Compiled by J. Price, A.M. Inst. C.E., Toxteth Park. 1891.
2	*Compiled by A. E. Nichols. Folkestone. 1906.
60	*Compiled by E. A. Borg, Margate.
	REFUSE (DESTRUCTORS).
15	Compiled by W. Brooke, A.M. Inst. C.E., Richmond. 1885.
33	Compiled by J. Gammage, Dudley. 1899.
	REFUSE (DISPOSAL OF).
16	Compiled by J. Price, A.M. Inst. C.E., Toxteth Park. 1896.
	REFUSE (REMOVAL OF).
17	Compiled by C. R. Fortune, Bath. 1886.
	ROADS (MAINTENANCE OF MAIN IN NON-COUNTY BOROUGHS).
18	Compiled by W. Howard-Smith, A.M. Inst. C.E., Carlisle. 1894.
	ROADS (PAVING OF MAIN).
31	Compiled by H. Richardson, A.M. Inst. C.E., Aston Manor. 1899.
	ROADS (STEAM ROLLING OF).
19	Compiled by A. W. Parry, A.M. Inst. C.E., Reading.
	ROADS (WATERING OF).
20	Compiled by W. Dawson, A.M. Inst. C.E., Leyton. 1891.

Ref. No.	
	SCAVENGING (STREET).
17	Compiled by C. R. Fortune, Bath. 1886.
	SEWAGE (DISPOSAL OF).
21	Compiled by J. H. Cox, M. Inst. C.E., Bradford. 1892.
22	Compiled by H. Richardson, A.M. Inst. C.E., Oldbury. 1890.
39	Compiled by J. W. Cockrill, M. Inst. C.E. 1900.
	SEWAGE DISPOSAL WORKS.
35	*Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.
	SEWAGE (PURIFICATION OF).
22	Compiled by H. Richardson, A.M. Inst. C.E., Oldbury. 1890.
	SEWERS (VENTILATION OF).
32	Compiled by J. T. Earnshaw, A.M. Inst. C.E., Ashton-under-Lyne. 1893.
51	*Compiled by H. G. Whyatt, Grimsby. 1900.
	*SEWER VENTILATION.
64	Compiled by J. Price, Birmingham. 1906.
	SLAUGHTER-HOUSES.
25	Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1885.
	STREETS (CONSTRUCTION OF NEW).
50	*Compiled by T. R. Smith, Kettering. 1902.
	SUPERANNUATION.
62	*Compiled by A. E. Collins, Norwich. 1906.
	SWIMMING BATHS.
61	*Compiled by P. R. A. Willoughby, Pontypridd. 1906.
	TEAM LABOUR.
52	*Compiled by T. J. Rushbrooke, Chepping Wycombe. 1904.
	TRAMWAYS.
26	Compiled by J. E. Swindlehurst, A.M. Inst. C.E. Burton-on-Trent. 1891.

Ref. No.	
	TRAMWAYS (ELECTRIC).
24	*Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1903.
34	Compiled by the Town Clerk of Birmingham. 1899.
43	Compiled by Chas. Mayne, A.M. Inst. C.E., Shanghai. 1897.
	UNDERGROUND TELEPHONE AND TELEGRAPH WIRES.
37	*Compiled by G. T. Lynam, A.M. Inst. C.E., Burton-on-Trent. 1899.
	WATER RATES.
44	Compiled by A. W. Lawson, A.M. Inst. C.E., Rawtenstall. 1898.
	WATER SUPPLY (DIAMETERS AND DEPTHS OF MAINS FROZEN IN 1895).
27	Compiled by E. Pritchard, M. Inst. C.E., Birmingham. 1895.
	WATER SUPPLY (FOR DOMESTIC AND GENERAL PURPOSES).
28	Compiled by J. T. Eayrs, A.M. Inst. C.E., West Bromwich. 1890.
	WORKMEN'S DWELLINGS.
29	*Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth. 1897.
	WORKMEN'S WAGES AND HOURS OF LABOUR.
4	Compiled by J. R. Dixon, A.M. Inst. C.E., Shoreditch. 1897.
30	Compiled by R. H. Haynes, Newport, Mon. 1897.
32	Compiled by S. E. Burgess, M. Inst. C.E., South Shields. 1899.

TRANSACTIONS OF OTHER SOCIETIES, BOOKS, ETC.

(Not available for loan.)

London Chamber of Commerce. Report on Secret Commissions. 1899.

London Chamber of Commerce. Report on Cement Admixtures. 1897.

British Fire Prevention Committee.

Field Work and Instruments. By A. T. Walmisley.
Glasgow Engineering Congress, 1901.
Institution of Mechanical Engineers.
Land Surveying and Levelling. By A. T. Walmisley.
Society of Engineers.
Stresses and Strains. By F. R. Farrow.
Structural Iron and Steel. By W. N. Twelvetrees.
The Sanitary Institute.

Special Reports.

(Not available for loan.)

Bacterial Treatment of Sewage. Prof. Frank Clowes, D.Sc. (London), and A. C. Houston, M.B. D.Sc. 1904.
Bacteriological Experiments with Sewage. Borough Surveyor, Leicester. 1900.
British Standard Sections. Engineering Standards Committee. 1903.
Disposal of Refuse, etc., in Cities of Melbourne and Adelaide, Report on. City Surveyor, Sydney. 1891.
Manchester Main Drainage, Report on. City Surveyor, Manchester. 1896.
Public Baths, Instructions, etc. to Architects. Surveyor to the Urban District Council, Handsworth. 1901.
Refuse Destructor and Electricity Works, Report on. Borough Engineer, Nelson. 1899.
Sewage Disposal, Report on. Borough Surveyor, Bradford.
Sewage Disposal Works, Specification, etc. for. Borough Engineer, Blackburn.
Sewage Purification. J. D. Watson. 1903.
Sewer Ventilation, Report on. Borough Engineer, Leicester. 1899.
Steam Road Rolling, Report on. County Surveyor, Hereford. 1897.
Storage of Flood Water. Prof. H. Robinson. 1899.
Town Refuse Destructors, Report on. Borough Surveyor of Ipswich. 1896.
Tramway Traction, Report on.
—— City Surveyor, Birmingham. 1899.
—— City Surveyor, Sheffield. 1897.

Treatment and Destruction of Refuse, Report on. City Surveyor, Sydney. 1897.

Well Sinking and Boring Operations. Surveyor to the Urban District Council, Handsworth. 1904.

Western Australian Hard Woods. Agent-General for Western Australia. 1902.

Pamphlets.

(Not available for loan.)

Conical Projection of Maps. R. H. Foy. 1901.

Destructors and Steam Production. W. H. Maxwell. 1901.

Formulæ and Tables of Velocities and Discharges of Sewers. T. De Courcy Meade. 1897.

Greater Manchester. J. Swarbrick. 1903.

Hardwoods of Western Australia. 1906.

Hodograph, the. T. Ferguson. 1901.

Incrustation of Iron Water Pipes. Water Engineer, Torquay.

Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M.B.

Presidential Address to Association of Birmingham Students. J. Price. 1902.

Raising of Water from Deep Wells by Compressed Air. W. H. Maxwell. 1903.

Timbers of Western Australia. 1906.

Type Drawings for Melbourne Sewerage. W. Thwaites, Chief Engineer, Melbourne.

Drawings of Lot's Road Pumping Station, L.C.C. Maurice Fitzmaurice, Chief Engineer.

Journals.

(Not available for loan.)

American Electrician.
 „ Electrical World and Engineer.
 „ Engineering Record.
Builder.
Cassier's Magazine.
Contract Journal.
Electrical Engineer.
Engineering Times.

Local Government Chronicle.
Local Government Officer.
Page's Magazine.
Sanitary Record.
Street Railway Journal.
Surveyor and Municipal and County Engineer.
The Quarry.
Water.

PAPERS.

A few prints of the following Papers (contained in past Volumes of 'Proceedings') are in stock at the Offices of the Association, and may be obtained from the Secretary, *if the* **Reference Number** *is quoted and an addressed postal wrapper is enclosed for each paper required.*

98 **Aberdeen, Municipal Engineering in.** W. Dyack.
97 **Aberdeen Waterworks.** J. Gordon.
86 **Coal-Mining Subsidences in Relation to Sewerage Works.** F. W. Mager.
96 **Electric Cable Subway.** G. R. G. Conway.
100 **Runcorn, Municipal Work in.** J. Wilding.
111 **Ventilation of Sewers.** A. W. Cross.
112 **Ventilation of Sewers.** R. Read.
102 **Whitehaven, Public Works of.** J. S. Brodie.
101 **Widnes, Municipal Works of.** J. S. Sinclair.

EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers undertake the holding of Examinations, by written papers and *vivâ voce*, in the four following subjects:—

Engineering as applied to Municipal work.
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Every candidate who applies for permission to sit for the Examination of the Association must possess one of the Certificates hereinafter mentioned in each of the following subjects:—

English, including (1) English Composition; (2) English Grammar, including Analysis and Parsing; (3) English History; (4) Geography.

Mathematics, including (1) *Arithmetic*—Vulgar and decimal fractions, proportion, square root, simple and compound interest, profit and loss, percentage, H.C.F. and L.C.M.; (2) *Algebra*—the ordinary rules; fractions; brackets; simple, simultaneous and easy quadratic equations, and problems involving the use of such equations; H.C.F.; L.C.M.; and square root; (3) *Euclid*—the first three books.

List of Certificates which will be accepted as evidence that Candidates possess the necessary qualifications in the various subjects:—

(1) English Composition and (2) English Grammar.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.

University of Tasmania: Senior Public Examination.

Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "English Composition," "English Language," and "English Literature."

Society of Arts: Advanced stage—First or Second Class, obtained since 1904; Intermediate stage—First Class, obtained since 1904; and the certificates corresponding thereto obtained prior to 1904.

College of Preceptors: First Class (or Senior), Second Class (or Junior), in the Professional Preliminary Examination; First Class (or Senior), Second Class (or Junior), in Certificate Examination.

Oxford Local: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass. *Cambridge Local*: Senior Examination—Honours or Pass. Junior Examination—Honours or Pass.	Certificate for English Language and Literature will be accepted as qualification required in English Composition and English Grammar.

(3) English History.

University of London: Matriculation Examination.

Victoria University: Preliminary Examination.

University of St. Andrews: Preliminary Examination in Science.

University of Glasgow: Preliminary Examination in Science.

University of Aberdeen: Preliminary Examination in Science.

University of Edinburgh: Preliminary Examination in Science.

University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.

University of Birmingham: Matriculation Examination.

King's College, London: Examination for the College Matriculation Certificate in Engineering.

University College, London: Matriculation Examination (Engineering Department).

Royal Indian Engineering College, Cooper's Hill: Entrance Examination.

City and Guilds of London Central Technical College: Matriculation Examination.

University College, Bristol: Preliminary Examination (Engineering Department).

Scotch Education Department: The Leaving Certificate.

Oxford and Cambridge Schools Examination Board: A Higher Certificate.

University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Society of Arts: As for English Composition and English Grammar. Certificate for Commercial History and Geography will be accepted as qualification required in English History and Geography.
College of Preceptors: As for English Composition and English Grammar.
Oxford Local: As for English Composition and English Grammar. Certificate for History will be accepted as qualification required in English History.
Cambridge Local: As for English Composition and English Grammar. Certificate (Senior or Junior) for History, Geography, etc., will be accepted as qualification required in English History and Geography.

(4) GEOGRAPHY.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Society of Arts: As for English History.
College of Preceptors: As for English Composition and English Grammar.
Oxford Local: As for English Composition and English Grammar.
Cambridge Local: As for English History.

MATHEMATICS.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.

University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
College of Preceptors: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
Oxford Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
Cambridge Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
Board of Education: Science Examination—Stage 1, First Class; or Stages 2 and 3, any Class.

The foregoing regulations do not apply to Candidates who have previously sat or received permission to sit.

A Candidate who has been awarded any of the undermentioned Certificates is exempt from further educational examination: The Institution of Civil Engineers, Studentship; The Royal Institute of British Architects, Preliminary; the Surveyors' Institution, Preliminary.

The Council reserve power to alter or add to the foregoing requirements.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

Examinations will also be held in Scotland and Ireland, providing a sufficient number of Candidates desire to enter. Examinations in Scotland will be held in October; in Ireland, in April.

The Council will consider applications, and, if desirable, grant permission, to sit at these Examinations.

Intending candidates who have not previously applied for permission to sit, must do so on the form issued with the syllabus.

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then make application on such form to be entered for the next ensuing, or any future, examination.

The Council will accept entries, in order of priority, as far as accommodation will permit.

Candidates who have sat and failed, or who have applied for and received permission to sit, are particularly requested to ask for a "sitting" form, when they desire to enter their names for examination.

The fee is to be sent with the sitting form ONLY.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is 4*l.* 4*s.*, two guineas to be paid with the "sitting" form, and the balance on the day of examination. Should the candidate fail, he is entitled to present himself at any subsequent Examination, on payment of 2*l.* 2*s.*, one guinea to be paid on application and one guinea on the day of Examination.

Candidates who sat and failed at any of the Examinations held prior to and including April 1898, pay 1*l.* 1*s.* entrance, and 10*s.* 6*d.* sitting fees.

No further charge is made to the candidate than the fees above mentioned.

Candidates who do not present themselves for examination forfeit their entrance fee.

Candidates are not necessarily required to answer all the questions set in each paper: marks are given for all questions correctly answered. Where the subject is sub-divided, at least one question should be attempted in each sub-section.

The Examinations occupy three days, and the arrangements are as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
„	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Engineering (1st Paper).
„	2.30 to 6	..	„ (2nd „).
Third day,	9.30 to 11.30	..	Municipal and Local Government Law.
„	12	..	*Vivâ voce* Examination.

Fifty per cent. of the total number of marks given are required to constitute a pass.

Successful candidates receive a Certificate in the form of a "Testamur," signed by the acting Examiners, and sealed and countersigned by the President and Secretary of the Association in Council.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the 'Proceedings.' On sale by Messrs. E. & F. N. SPON, Ltd., Publishers, 57 Haymarket, S.W. The questions set at subsequent examinations are not published.

No exemption from any portion of the Examination is granted to candidates.

Any inquiries referring to the Examinations should be directed to Mr. Thomas Cole, Secretary to the Association, 11 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work:

1st Paper.—A. Sewage Disposal.
B. Tramways Construction.
C. Bridge Construction.
D. Water Supply.

Questions in TWO at least of these subjects must be attempted.

2nd Paper.—A. Geodesy.
B. Hydraulics.
C. Sewerage.
D. Road Construction and Maintenance.

II.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building By-laws.
D. Public Baths and Hospitals.

III.—Sanitary Science as applied to Towns and Buildings:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

IV.—Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—"You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Fill in your number where indicated, also at the top of every book handed in. Place this question-paper inside your book before handing it in. Prefix the number of the question to each answer. Where the subject is sub-divided, at least one question should be attempted in each sub-section.* Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the Candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, or communicate with each other. Slide rules may not be used."

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

FIRST PAPER.

SEWAGE DISPOSAL.

1. A residential town of 10,000 inhabitants, with an adequate water supply, has to be sewered and drained on to a square piece of land, 23 acres in extent, through the centre of which runs a stream, the land rising therefrom at a gradient of 1 in 50 on one side, and 1 in 130 on the other. The soil is loam, of an average depth of 2 ft. 6 in., on a substratum of friable clay. Two-thirds of the sewage can gravitate to the uppermost portion of land, the remainder is below bed of stream. Describe and illustrate by sketches the system of disposal you would recommend under these circumstances, giving particulars of construction, capacity, cost, quantity of sewage to be dealt with, (*a*) if storm-water included, (*b*) if excluded; also state standard of purity of effluent you consider satisfactory.

2. Describe one or more forms of aerating beds or filters for sewage purification, together with the arrangements for distributing the sewage thereon. State the object of such beds or filters, and the points in favour of the method of distribution you prefer, as compared with any other method known to you.

Tramways Construction.

3. Make a sketch of the cross section of a tramway worked on the overhead system, double track, standard gauge, on a 50-ft. road, and briefly describe the mode of construction of the permanent way.
4. (*a*) Sketch a section of a tram rail for electric traction with heavy traffic, giving dimensions in detail and weight per yard, and state the chief points to be observed in its chemical composition.
   (*b*) Similarly sketch a joint.
   (*c*) State the advantages and disadvantages (if any) of such a joint.

Bridge Construction.

5. Show a method of connecting a cross girder of a steel road bridge to the bottom boom of main girder, and of floor construction for the bridge. The bridge is 40 feet wide between main girders which form the parapets. Cross girders at 10 ft. centres. Total of dead and live loads, which may be taken as equally divided, 3 cwt. per superficial foot of floor surface. Candidate may select type of main and cross girders, and floor construction.
6. (*a*) Give the points to be considered in designing a steel girder road bridge of 100 ft. span and 42 ft. clear width between the main girders.
   (*b*) Briefly state the tests you would apply to the various parts of the bridge.

Water Supply.

7. An open reservoir, 20 ft. deep, has to be constructed on the side of a hill having a slope of 1 in 25, the foundation being large boulders and loose shale under 3 ft. of peaty soil. 180 days' storage has to be provided for a residential town of 20,000 inhabitants. Sketch and figure section through lower and upper sides and floor, and indicate the different materials used. Give cubical contents in feet and gallons, and the pressure per square foot on centre of floor and half-way up the side, when the reservoir is three-fourths full.
8. Describe and illustrate an apparatus by means of which a water main whilst remaining under pressure, may be drilled, tapped, and a service ferrule connected.

SECOND PAPER.

Geodesy.

1. It is proposed to purchase for a recreation ground, a four-sided field, 672 ft., 393 ft., 806 ft., and 297 ft., measured to centre of hedges, the ditch being inside in each case. Near the centre is a small irregularly-shaped orchard, about 90 poles in area, surrounded by an impenetrable hedge. Show by sketch plan your plotting out, give area, and cost at 300*l.* per acre.

2. State how you would test a level for parallax, and adjust it; and the method of testing and correcting for collimation.

Hydraulics.

3. What is the discharge of a water main 6 in. diameter, 2000 ft. long, with a fall of 15 feet?
4. What would be the quantity of water per minute which would run over a rectangular notch 1 ft. wide, and 1 ft. in depth from the water's surface, and show the calculations by which you arrive at the result?

Sewerage.

5. Sketch cross section of an egg-shaped sewer 5 ft. high, to be constructed through water-logged ground, giving diameters at top and bottom, radius of sides, and area. Indicate materials used, figure thicknesses, and write brief specification, including method of testing to be adopted. Give quantity of sewage discharged, if running 2 ft. 7 in. deep, with a velocity of 2 ft. per second.

6. You have a main outfall sewer with a 1 per cent. fall, and wish to connect a branch sewer from a higher district, the valley sides being so steep that you must have a 5 per cent. fall. How would you propose to reduce the velocity in the branch so that in heavy floods the main sewer would not be choked or blown up?

Road Construction and Maintenance.

7. A road 20 ft. wide, a mile long, having but little waste at sides, with a very slight fall from either end to near the centre, where is the only outlet for storm-water, has been destroyed by heavy traffic, there being no foundation other than coarse sand and gravel 18 inches deep, over stiff clay. Describe, by short specification and sketches, how you would proceed to thoroughly re-instate and drain the road, using the prices of the various materials and labour prevalent in your own neighbourhood; and give the quantities required, and estimate cost of work.

8. What are the advantages and disadvantages respectively of maintaining macadamised roads by the system of continuous coatings, as compared with the system of systematic patching?

SUBJECT :—BUILDING CONSTRUCTION.

A. MATERIALS.

1. What descriptions of timber are best suited for the construction of outside work? Name them in order of merit.

2. Write a specification of good hair mortar.

3. Give the proper thicknesses of sheet lead in lbs. per square foot used on roofs in various parts, giving the trade terms.

B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

1. What is meant by a "king post" and a "queen post" principal? Make a sketch of each, with scantlings, applied to spans of 25 feet and 50 feet respectively, and state distances between the principals.

2. What proportions of cement, sand and broken brick or stone would you specify for concrete for
   (a) Foundations for main walls.
   (b) Concrete stair landings.
   (c) Water-tight work.

3. Draw a figured section of a wrought-iron girder over a shop, 20 feet clear span, to carry front wall of house, two stories, 23 feet total height, and the floor joists of two rooms, the thickness of the wall to be 1½ brick.

C. BUILDING BY-LAWS.

1. State the means of ventilation required to be provided for a "habitable room without a fire-place."

2. What proportion do the "Model By-Laws" prescribe for the open space in rear of a dwelling, and how to be measured?

3. State generally the requirements of these by-laws as to—
   (a) The levels, widths and construction of new streets.
   (b) The construction of water-closets in a building.

D. PUBLIC BATHS AND HOSPITALS.

1. Give sketches and descriptions of a covered swimming-bath pond, and of the heating and overflow arrangements thereof.

2. In case of a temporary hospital for immediate requirements, give sketch plan showing position of closets, bath, nurses' room and administrative departments.

SUBJECT:—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS.

A. HEATING AND VENTILATION.

1. How would you warm and ventilate a ward in an infectious diseases hospital?
2. Describe various methods of ventilating sewers, and give opinions as to the merits or otherwise of the same.
3. Describe the system you would employ for ventilating a theatre of average size, assuming your own conditions.

B. SCAVENGING AND DISPOSAL OF REFUSE.

1. Describe, so far as house refuse is concerned, the best mode of collection.
2. How many cells would you specify in a refuse destructor for a population of 40,000 in a residential town?
3. Give a short description of the "conservancy" systems of disposal of town's refuse, and the advantages or disadvantages of each system.

C. WATER SUPPLY AND DRAINAGE OF BUILDINGS.

1. State the advantages of soft water and of hard, comparatively.
2. A dwelling house is to be erected on damp subsoil; describe in detail the necessary works to render it dry and healthy.
3. What gradient would be necessary in 4, 6 and 9-inch pipe to ensure self-cleansing?

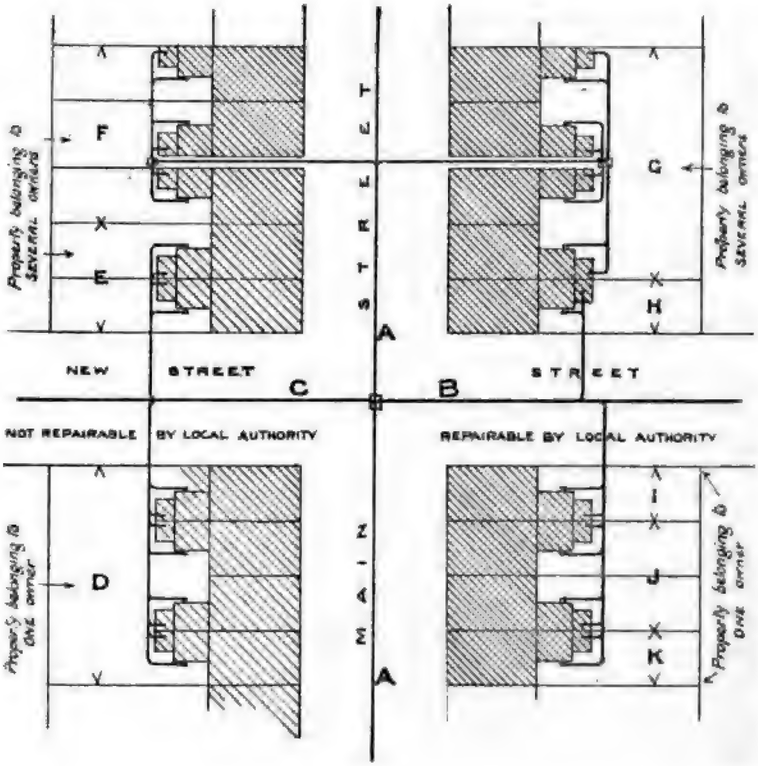
D. DISINFECTION.

1. Describe a disinfecting station suitable for a town of 40,000 population, noticing the special points, and giving the principal dimensions. Give an approximate estimate of cost excluding land, stating cost of 9-inch brickwork per square yard.
2. Describe various forms of disinfecting apparatus.
3. What method would you adopt to prevent the spread of infectious disease which has broken out in a crowded portion of the district?

SUBJECT :—**MUNICIPAL AND LOCAL GOVERNMENT LAW** AS RELATING TO THE WORK OF MUNICIPAL AND COUNTY ENGINEERS AND SURVEYORS.

(England)

1. Mark on the accompanying plan which are "sewers" and which are "drains" in connection with the streets A, B and C, and the properties D to K respectively, giving the grounds upon which you base your conclusions.



2. State the provisions of the Public Health Acts Amendment Act, 1890, with respect to "Sanitary Conveniences for manufactories." What number of water-closets should you consider sufficient for (*a*) 100 males; (*b*) 100 females?

3. Specify the duty of a local authority with respect to (*a*) nuisances; (*b*) epidemics.

4. Give a short outline of Act for Housing of the Working Classes, and the responsibility of a local authority where the same has been adopted.

5. An urban authority desires to widen and improve a public street. State the different methods of proceeding. Name the various Acts and clauses.

6. What are the regulations prescribed in the Tramways Act, 1870, with regard to opening, breaking up and altering the level of roads by a tramway company for the purpose of making, maintaining and renewing a duly authorised tramway?

7. What is the meaning of the term "main road," used in the Local Government (England and Wales) Act, 1888, and in the Highways and Locomotives (Amendment) Act, 1878?

8. What steps must a local authority take before commencing sewerage or sewage works without their district?

9. In what manner, and under what Act, may ruinous or dangerous buildings be dealt with?

Municipal and Local Government Law as Relating to the Work of Municipal Engineers and Surveyors.

(Scotland)

1. Define the various roads to which these words apply, viz., Highway, Turnpike Road, Statute Labour Road, as interpreted by the Roads and Bridges (Scotland) Act, 1878.

2. Describe the statutory provisions whereby a local authority can recover from any person expenses for damage to highways caused by extraordinary traffic thereon, or by excessive weight passing along the same; and state in what Act of Parliament these provisions are embraced.

3. To whom must application be made for authority to lay out new streets? Specify the details which require to be shown on the plan accompanying the application.

4. If a Burgh should desire to improve any existing private streets, what statutory procedure would be necessary?

5. What are the powers of a Burgh with reference to the keeping of footpaths of public streets in proper repair? How far do these powers apply to private streets?

6. Specify the procedure which must be adopted in a Police Burgh before a public sewer can be laid. Under what Act is this necessary?

7. What powers of entry are given under the Public Health (Scotland) Act for the purpose of examining drains, and what is the necessary procedure?

8. Specify the duty of a Local Authority with reference to the water supply of buildings in an isolated district.

9. Enumerate the powers given for the formation of special water supply districts. State briefly under what circumstances a Local Authority is bound to take action.

10. What were the requirements of the 1892 Burgh Police (Scotland) Act with regard to back space for proposed buildings, and what alteration was made by the 1903 Act?

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52nd, 53rd, and 54th Examinations, April 1906.

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Memoirs of Deceased Members.

THE Council, having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these "Proceedings."

Mr. WILLIAM HENRY ROBINSON CRABTREE, late Borough Surveyor of Doncaster, died on December 27, 1905, after an operation for appendicitis, in the forty-ninth year of his age, and, by a pathetic coincidence, on the twenty-fifth anniversary of his marriage. Mr. Crabtree served his articles with his father, the late Mr. William Crabtree, M. Inst. C.E., for twenty-nine years the Borough Surveyor of Southport, and was engaged on the Southport main sewerage works, designed by the late Mr. James Mansergh, F.R.S., as assistant to Mr. H. U. McKie and Mr. Morrow, successive resident engineers. In 1878 he was Resident Engineer on sewerage works at Southport, and in 1879 and 1880 was Resident Engineer on the North Promenade extension works and sea-wall at Southport, designed by his father, by which 43 acres of land were reclaimed from the sea. In 1880 he permanently joined the staff of Mr. Mansergh, and helped to carry out many important works, including sewerage and water schemes at Sherburn, Bethesda, and Withington, and the Rotherham waterworks. He was appointed Borough Surveyor and Waterworks Engineer of Doncaster in 1887, since which time he had played a leading part in carrying out the erection of the electricity works, the inauguration of the tramway system, the erection of Corporation schools on entirely modern principles, the erection and extension of stands on the racecourse, the widening of streets and erection of new buildings, the extension of the waterworks, and the low pasture sewerage

scheme. At the time of his death he had completed plans for carrying out three important schemes—the erection of schools, of a higher municipal school, and a model lodging-house, involving an expenditure of over 50,000*l*. As a public official Mr. Crabtree was competent, courteous, and conscientious in the highest degree, and a man in whom everyone had the highest confidence, trust and respect. Mr. Crabtree was elected a Member in December 1887.

Mr. James Edward Fothergill, late Surveyor to the Brentwood Urban District Council, died in July 1905. Mr. Fothergill was an able and efficient officer, conscientious and painstaking, and held the regard and esteem of every member of his Council. In the discharge of his duties, although those duties were sometimes of an onerous nature, and naturally would occasionally bring him into conflict possibly with individuals, such was his tact and judgment that he never made an enemy, and all with whom he came in contact had good feeling towards him. Mr Fothergill was elected a Member in June 1900.

Mr. William Henry Hopkinson, late Borough Engineer of Keighley, died on April 10, 1906, from an attack of pleurisy and pneumonia. He was fifty years of age. Mr. Hopkinson, who had for some years past fulfilled the duties of hon. secretary of the Yorkshire District, commenced his career in the office of the borough engineer and surveyor of Halifax, remaining there for thirteen years, and attaining to the position of Assistant Surveyor. While holding this post he assisted in carrying out a considerable portion of the main sewerage works, the paving of the bed of the river, and the carrying out of extensive street improvements. In September 1883 he was appointed to Keighley, succeeding Mr. Weatherall, and in 1892 the Corporation, having numerous important engineering works to carry out, appointed him to the position of Borough Engineer. His principal works under the Keighley Corporation were the construction of the Marley sewage disposal works, at a cost of about 30,000*l*.; the construction of the filter beds in connection with the waterworks at Oldfield, at a cost of about 20,000*l*.; and latterly the laying of the permanent way for the electric tramways. Mr. Hopkinson was elected a Member in September 1889.

Mr. GERALD EDWIN HULL, late Chief Resident Engineer to the municipality of Benares, India, passed away May 18, 1906, in his twenty-ninth year. He served his articles with Mr. Arthur E. Collins, the city engineer of Norwich, from 1894 to 1897, and became that gentleman's assistant in the following year. He afterwards entered the office of the late Mr. John Price, city surveyor of Birmingham, later on securing an appointment at Coventry. In 1903 he was selected for the position of Assistant Resident Engineer to the municipality of Benares, and a year ago was promoted to the higher post which he filled up to the time of his death. Mr. Hull was a young man of great promise, and his untimely end is deeply lamented by all with whom he had come into contact in the course of his professional career. He was elected a Graduate in August 1901, and was transferred to Member in December 1904.

Mr. FRANCIS JOSEPH MORRIS, late Borough Surveyor of Grantham, died somewhat suddenly at Sleaford on March 12, 1906, in the fortieth year of his age. He received his appointment in 1896. He was a capable and courteous official, and carried out many improvements in Grantham. Mr. Morris was elected a Member in June 1898.

Mr. JOHN PRICE, late City Surveyor, Birmingham, died on March 6, 1906, after an operation for appendicitis and peritonitis in the fifty-first year of his age. Mr. Price had been in the service of the city of Birmingham since 1896, first as Assistant Surveyor and Deputy Engineer to the drainage board, and afterwards as City Surveyor. He was educated at the Manchester Grammar School and the Victoria University, where he obtained the Ashbury exhibition for civil engineering. In 1871 he entered the office of Mr. Hartley Watson, of Manchester, as articled pupil, and in 1874 took charge of the Hollingwood branch of the Lancashire and Yorkshire Railway, as Engineer to the contractor. In 1876 he went to Barrow-in-Furness, and entered the office of Mr. Arthur Jacobs, who was consulting engineer to the Barrow Corporation, and he was engaged upon the designs for the drainage of the town. When Mr. Jacobs was appointed to Salford, Mr. Price was elected Resident Engineer. In 1878 he accepted the appointment of Engineer and Surveyor to the sanitary authority of Darton, near Manchester, and held

that post until he was appointed Engineer and Surveyor to the Toxteth Park Local Board, Liverpool, in 1884. This district was subsequently included in the City of Liverpool in 1895, and Mr. Price then became Assistant City Engineer, at a salary of 550*l.* In the following year Mr. W. S. Till, who had been the Birmingham surveyor and engineer for a great number of years, retired, and in September Mr. Price was appointed to the office, the services of Mr. Till being retained as consulting engineer. Mr. Till died early in 1898, and Mr. Price was then appointed City Surveyor. He was elected a Member in May 1879.

CHARLES DONALD MAQUEEN TRINDER, late Surveyor to the Claypole (Lincs.) Rural District Council, died September 8, 1905, as the result of a distressing cycling accident, in the thirty-third year of his age. Mr. Trinder received his early training in the office of Mr. E. Purnell Hooley, county surveyor of Nottinghamshire, and was appointed Surveyor to the Claypole Rural District Council in March 1895. He was a man of great ability and tact, and had the control of 206 miles of road. Under his supervision the highways maintained by the Claypole council had greatly improved, and he was very successful with various drainage schemes. A new bridge at Claypole, which has superseded the historic one that had carried the traffic there for 600 years, was built from his plans, while another bridge was erected from his designs at Norton Disney. Mr. Trinder was elected a Member in February 1897.

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